

DESIGN-BUILD REQUEST FOR PROPOSAL

AIT FACILITY – PHASE I
FT. EUSTIS, VIRGINIA
PN: 66714 FY10

US ARMY CORPS OF ENGINEERS
NORFOLK DISTRICT

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SECTION 01 10 00.0006
TASK ORDER STATEMENT OF WORK

1.0 PROJECT OBJECTIVES

1.1. SECTION ORGANIZATION

2.0 SCOPE

2.1. ADVANCED INDIVIDUAL TRAINING COMPLEX

2.2. SITE

2.3. GOVERNMENT-FURNISHED GOVERNMENT INSTALL EQUIPMENT (GFGI)

2.4. FURNITURE REQUIREMENTS

3.0 ADVANCED INDIVIDUAL TRAINING COMPLEX

3.1. GENERAL REQUIREMENTS

3.2. FUNCTIONAL AND AREA REQUIREMENTS

4.0 APPLICABLE CRITERIA

4.1. INDUSTRY CRITERIA

4.2. MILITARY CRITERIA

4.3. PRECEDENCE

5.0 GENERAL TECHNICAL REQUIREMENTS

5.1. SITE PLANNING AND DESIGN

5.2. SITE ENGINEERING

5.3. ARCHITECTURE AND INTERIOR DESIGN

5.4. STRUCTURAL DESIGN

5.5. THERMAL PERFORMANCE

5.6. PLUMBING

5.7. ELECTRICAL AND TELECOMMUNICATIONS SYSTEMS

5.8. HEATING, VENTILATING AND AIR CONDITIONING

5.9. ENERGY CONSERVATION

5.10. FIRE PROTECTION

5.11. SUSTAINABLE DESIGN

5.12. CONSTRUCTION AND DEMOLITION (C&D) WASTE MANAGEMENT

5.13. SECURITY (ANTI-TERRORISM STANDARDS)

6.0 PROJECT SPECIFIC REQUIREMENTS

6.1. GENERAL

6.2. APPROVED DEVIATIONS

6.3. SITE PLANNING AND DESIGN

6.4. SITE ENGINEERING

6.5. ARCHITECTURE

6.6. STRUCTURAL DESIGN

6.7. THERMAL PERFORMANCE

6.8. PLUMBING

6.9. SITE ELECTRICAL AND TELECOMMUNICATIONS SYSTEMS

6.10. FACILITY ELECTRICAL AND TELECOMMUNICATIONS SYSTEMS

6.11. HEATING, VENTILATING AND AIR CONDITIONING

6.12. ENERGY CONSERVATION

6.13. FIRE PROTECTION

6.14. SUSTAINABLE DESIGN

6.15. ENVIRONMENTAL

6.16. PERMITS

6.17. DEMOLITION

6.18. ADDITIONAL FACILITIES

1.0 PROJECT OBJECTIVES

The project objective is to design and construct facilities for the military that are consistent with the design and construction practices used for civilian sector projects that perform similar functions to the military projects. For example, a Company Operations Facility has the similar function as an office/warehouse in the civilian sector; therefore the design and construction practices for a company operations facility should be consistent with the design and construction of an office/warehouse building.

Comparison of Military Facilities to Civilian Facilities

Military Facility	Civilian Facility
Barracks/Company Operations Facility (B/COF)	Dormitory / Office Building
Central Cooling Plant (CCP)	Chiller/Condenser Water Plant
Lawn Equipment Building (LEB)	Storage Shed

It is the Army's objective that these buildings will have a 25-year useful design life before a possible re-use/re-purpose or renovation requirement, to include normal sustainment, restoration, modernization activities and a 50-year building replacement life. Therefore, the design and construction should provide an appropriate level of quality to ensure the continued use of the facility over that time period with the application of reasonable preventive maintenance and repairs that would be industry-acceptable to a major civilian sector project OWNER. The site infrastructure will have at least a 50-year life expectancy with industry-accepted maintenance and repair cycles.

The project site should be developed for efficiency and to convey a sense of unity or connectivity with the adjacent buildings and with the Installation as a whole.

Requirements stated in this contract are minimums. Innovative, creative, and life cycle cost effective solutions, which meet or exceed these requirements are encouraged. Further, the OFFEROR is encouraged to seek solutions that will expedite construction (panelization, pre-engineered, etc.) and shorten the schedule. **The intent of the Government is to emphasize the placement of funds into functional/operational requirements. Materials and methods should reflect this by choosing the lowest Type of Construction allowed by code for this occupancy/project allowing the funding to be reflected in the quality of interior/exterior finishes and systems selected.**

1.1. SECTION ORGANIZATION

This Section is organized under 6 major "paragraphs".

- (1) Paragraph 1 is intended to define the project objectives and to provide a comparison between the military facility(ies) and comparable "civilian" type buildings.
- (2) Paragraph 2 describes the scope of the project.
- (3) Paragraph 3 provides the functional, operational and facility specific design criteria for the specific facility type(s) included in this contract or task order.
- (4) Paragraph 4 lists applicable industry and government design criteria, generally applicable to all facility types, unless otherwise indicated in the Section. It is not intended to be all-inclusive. Other industry and government standards may also be used, where necessary to produce professional designs, unless they conflict with those listed.
- (5) Paragraph 5 contains Army Standard Design Criteria, generally applicable to all facility types, unless otherwise indicated in the Section.
- (6) Paragraph 6 contains installation and project specific criteria supplementing the other 5 paragraphs.

2.0 SCOPE

2.1. ADVANCED INDIVIDUAL TRAINING COMPLEX

2.1.1. BARRACKS/COMPANY OPERATIONS FACILITY

Provide 1 standard B/COFs. This facility type is to house single trainee soldiers and company administrative, training and command operations.

Maximum number of single personnel to be housed is 300 per B/COF. Each B/COF shall be three stories high and shall house 100 soldiers per floor.

The maximum gross area for each B/COF is 93,000 square feet.

The floor plans provided in Appendix J are mandatory and indicate functional arrangements that meet user operability requirements. The design/Build (D/B) Contractor is required to adhere to these mandatory designs. Minor plan alterations (less than 6") are permitted to accommodate building system requirements; however, the Minimum Area Requirements shall not be reduced in order to accommodate building system requirements.

2.1.2. NOT USED

2.1.3. NOT USED

2.1.4. CENTRAL COOLING PLANT

Provide one CCP. This facility type is to produce cooling for the AIT Complex.

The maximum gross area for the CCP is 0 square feet.

2.1.5. LAWN EQUIPMENT BUILDING

Provide one LEB. This facility type is to store lawn maintenance equipment. There is no fuel storage.

The maximum gross area for the LEB is 2,000 square feet.

2.2. SITE:

Provide all site improvements necessary to support the new building facilities. Refer to Paragraph 6.

Include Antiterrorism/Force Protection measures in the facility design in accordance with applicable criteria. The Contractor shall be responsible for all repairs to existing sidewalks, pavements, curb and gutter, utilities, and/or landscaping damaged as a result of his construction activities.

Approximate area available 12.00 acres in the limits of construction, as shown on the site layout plan. Refer to Appendix J - Drawings.

2.3. GOVERNMENT-FURNISHED GOVERNMENT-INSTALLED EQUIPMENT (GFGI)

Coordinate with Government on GFGI item requirements and provide suitable structural support, brackets for projectors/VCRs/TVs, all utility connections and space with required clearances for all GFGI items. Fire extinguishers are GF/GI personal property, while fire extinguisher brackets and cabinets are Contractor furnished and installed CF/CI. Include tables/cabinets/carts/etc. for GFGI equipment that is not freestanding in furniture design. All Computers and related hardware, copiers, faxes, printers, video projectors, VCRs and TVs are GFGI.

The following are also GFGI items: No Additional Government Furnished, Government Installed Equipment.

2.4. FURNITURE REQUIREMENTS

Provide furniture design for all spaces listed in Chapter 3 and including any existing furniture and equipment to be re-used. Coordinate with the user to define requirements for furniture systems, movable furniture, storage systems, equipment, any existing items to be reused, etc. Early coordination of furniture design is required for a complete and usable facility.

The procurement and installation of furniture is NOT included in this contract. Furniture will be provided and installed under a separate furniture vendor/installer contract. The general contractor shall accommodate that effort with allowance for entry of the furniture vendor/installer onto this project site at the appropriate time to permit completion of the furniture installation for a complete and usable facility to coincide with the Beneficial Occupancy Date (BOD) of this project. The furniture vendor/installer contract will include all electrical pre-wiring and the whips for final connection to the building electrical systems however; the general contractor shall make the final connections to the building electrical systems under this contract. Furthermore, the general contractor shall provide all Information/Technology (IT) wiring (i.e. LAN, phone, etc.) up to and including the face plate of all freestanding and/or systems furniture desk tops as applicable, the services to install the cable and face plates in the furniture, the coordination with the furniture vendor/installer to accomplish the installation at the appropriate time, and all the final IT connections to the building systems under this contract.

The Government reserves the right to change the method for procurement of and installation of furniture to Contractor Furnished/Contractor Installed (CF/CI). CF/CI furniture will require competitive open market procurement by the Contractor using the Furniture, Fixtures and Equipment (FF&E) package.

2.5. NOT USED

3.0 ADVANCED INDIVIDUAL TRAINING COMPLEX (AIT)

3.1. General

Advanced Individual Training (AIT) complexes are required by the Army to encompass living, dining, training, and administrative/command operations. This AIT complex will be comprised of: Barracks/Company Operations Facilities (B/COF), Central Cooling Plant (CCP), Lawn Equipment Buildings. These facilities, with outdoor training areas and any additional support facilities, shall be arranged on the site as a unit to allow the battalion to live, eat, train, and work together.

B/COF is comprised of sleeping units, toilets, computer learning centers, multipurpose space, storage, laundry areas, day rooms, and company operations components.

CCP consists of enclosed space for equipment and required maintenance space. No administrative, conference, or operator office is authorized.

LEB is a storage building for lawn maintenance equipment.

3.2. FUNCTIONAL AND AREA REQUIREMENTS

Gross building area shall be calculated in accordance with Appendix Q. Net area is measured to the inside face of the room or space walls. Minimum dimension where stated shall be measured to the inside face of the defining enclosure. Net area requirements for programmed spaces are included in this paragraph. If net area requirements are not specified, the space shall be sized to accommodate the required function and to comply with code requirements, overall gross area limitations, and any other requirement of this RFP. Area requirements for corridors, stairs, and mechanical rooms will typically be left to the discretion of the offeror.

3.2.1. ACCESSIBILITY REQUIREMENTS

The B/COF and LEB facilities are intended for occupancy and/or use by able-bodied military personnel only. In accordance with paragraph 3(a) of the Deputy Secretary of Defense Memorandum dated 31 October 2008: DoD Access for People with Disabilities, facilities for able-bodied personnel are exempt from accessibility requirements. Headquarters buildings shall comply with the Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities as currently amended. In accordance ABA Section F203.6, Central Energy Plants, if provided, are exempt from accessibility requirements.

3.2.2. B/COF

3.2.2.1. B/COF Functional Space Requirements

3.2.2.1.1. Sleeping Units

(a) Bedroom: Each sleeping unit shall have one, two person bedroom. Bedrooms must be of equal size and able to accommodate scheduled GFGL furniture with adequate circulation. Provide one full length wall mirror (16 to 24 inches by 72 inches). Mount full length wall mirror at the end of plumbing chase in each sleeping unit. Bedrooms must be of equal size and able to accommodate scheduled GFGL furniture with adequate circulation as listed below.

(i) Space for a single bed with headboard, footboard and 40in. x 85in. mattress.

(ii) Space for free-standing nightstand 18 in. to 26 in. wide x 16 in. to 20 in. deep x 20 in. to 24 in. high with table lamp.

(iii) Space for computer desk 60 in. wide x 25 in. deep x 30in. high with keyboard tray retracted and overhead study carrel.

(iv) Space for ergonomic task chair, 16 in. to 21 in. high by 15 in. to 18 in. deep with adjustable arm height.

(b) Bathroom: Each sleeping unit shall have one bathroom with water closet and shower. Extend ceramic tile shower surround to ceiling. Provide tamper resistant showerhead with an elevation of 6'-6".

- (c) Entry: Each sleeping unit entry area shall have three lockable built-in closets and a lavatory with a solid surface vanity countertop. Each built-in closet shall have interior dimensions of 36 inches wide by 25 inches deep, with rod and shelf. Provide in each closet two 36 inch wide by 18 inch deep shelves set at 18 inches and 30 inches vertically above closet floor and capable of supporting a minimum of 15 pounds per linear foot. Each vanity shall have storage cabinets below, recessed mirrored medicine cabinet and a towel bar. Locate vanity immediately outside of bathroom.
- (d) Utility Closet: Provide one utility closet per sleeping unit to house the HVAC fan cooling/heating unit. Utility closet shall be accessed from the corridor only.

3.2.2.1.2. Common Areas

- (a) Lobby: Provide an entry lobby. Provide space to accommodate scheduled GFGI furniture with adequate circulation as listed below.
- Space for six (6) guest chairs
- (b) Vestibule: Provide an enclosed transition space between the exterior and interior of the building. The vestibule shall be a minimum of 7 feet between doors.
- (c) Stair: Provide 4 feet 6 inch minimum width stairs.
- (d) Corridors: Provide 6 feet minimum width corridors.
- (e) Charge of Quarters (CQ) Station: Provide a built-in reception station located in the central portion of the lobby with a minimum area of 50 net square feet. Built-in station shall provide modesty screening for occupant. Station provides visual control of building circulation. The reception station shall have a minimum of six lockable file drawers. Securable compartments for the computer monitor, keyboard, and CPU shall be built-in the reception station.
- (f) Drill Instructor (DI) Office: Provide private administrative office with a toilet/shower on each floor. Each DI office shall be designed to accommodate three work stations. Provide a dressing area with a built-in 18 inch wooden bench adjacent to the shower area. Square footage for toilet/shower is included in the overall DI office space allocation. Each DI office shall be able to accommodate scheduled GFGI furniture with adequate circulation as listed below.
- Three (3) open work areas with 48 NSF to include:
 - Space for a worksurface 60 in. to 72in. wide x 30in. to 36in. deep, a worksurface 29 in. to 48in. wide x 15in. to 24in. deep with file pedestal.
 - Space for overhead storage
 - Space for ergonomic task chair, 16in. to 21in. wide x 15in. to 18in. deep with adjustable arm height.
 - Space for four (4) guest chairs
- (g) Computer Learning Center: Provide on each floor one classroom area designed for computer usage with a lockable storage room. Storage room shall have a net area of 68 square feet and shall have a minimum of six, 18 inch deep storage shelves, spaced at 12 inches on center vertically and capable of supporting a minimum of 20 pounds per linear foot. Total linear footage of storage shelves shall be three times the perimeter of the storage room. Square footage for storage room is included in the overall computer learning center space allocation. Each Computer Learning Center shall be able to accommodate scheduled GFGI furniture with adequate circulation as listed below.
- Space for twenty-four (24) computer carrels 48in. wide x 30in. deep.
 - Space for twenty-four (24) ergonomic task chairs 16in. to 21in. wide x 15in. to 18in. deep with adjustable arm height.
 - Space for one (1) storage cabinet
- (h) Day Room: Provide a day room on each floor. Day room functions as a soldier's lounge and includes a lockable storage room. Storage room shall have a net area of 68 square feet and shall have a minimum of six, 18 inch deep storage shelves, spaced at 12 inches on center vertically and capable of supporting a minimum of 20 pounds per linear foot. Total linear footage of storage shelves shall be three times the perimeter of the storage room. Square footage for storage room is included in the overall day room space allocation. Locate a vending area in day room. Size each vending area to accommodate two full size vending machines. Provide power receptacles for vending machines. Each Day Room shall be able to accommodate scheduled GFGI furniture with adequate circulation as listed below.

- Space for 7-seat upholstered arrangement-typical
 - One (1) three seat cushioned sofa 72in. to 90in. wide x 32in. to 35in. deep
 - Two (2) two-seat sofa 50in. to 60in. wide x 32in. to 35in. deep
- Space for two (2) side tables 22in. to 26in. wide x 20 in. to 26in. deep x 23 in. high.
- Space for one (1) 36" round table with four guest chairs.
- Space for an entertainment system storage 53in. to 60in. wide x 20in. to 24in. deep x 25in. to 32in. high
- Space for one (1) pool table 96in. to 120in. wide x 57in. to 105in. and/or one (1) table tennis 60in. wide x 108in. long.

(i) Laundry: Provide one laundry room on each floor, located in the central core area. Laundry room door shall be 36 inches wide minimum. Furnish self-serve laundry facilities at ratios of 8 persons per washer and 6 persons per dryer at a surge population of 450 persons. This equals a minimum total of 58 heavy-duty, extra capacity washers and 76 heavy-duty, extra capacity dryers in the facility. GFGI dryers are stackable type. Contractor furnished and installed fixed heavy gauge stainless steel clothes folding/hanging tables and stainless steel utility sinks are required features of centralized laundry facilities. In each laundry room provide clothes folding/hanging tables, each measuring 2 feet deep by 5 feet wide. Designers are encouraged to design laundry rooms that are identical from floor to floor. However where this is not feasible, no floor shall provide less than 14 washers and 20 dryers (approx. 25%), with the remainder of the total required units to be provided on the remaining floors. Laundry room design shall include space and power receptacles for a GFGI laundry supplies vending machine in each laundry room. Provide power receptacles, water and drain connections for all washers. Provide power receptacles, natural gas connection (where gas is available to site) and vent connections for all dryers. Dryers shall be exhausted to the exterior.

(j) Luggage Storage: Provide two lockable luggage storage areas per floor with a minimum of six 24 inch deep shelves, spaced at 24 inches on center vertically and capable of supporting a minimum of 30 pounds per linear foot. Total linear footage of storage shelves shall be three times the perimeter of the storage room.

(k) Not Used

(l) Janitor: Provide two janitor's closets per floor. Each janitor's closet shall have a 10 inch deep floor mounted stainless steel mop sink, with hot and cold service faucet, a four holder mop rack and two 18 inch deep by 48 inch long heavy duty stainless steel shelves for storage of cleaning supplies. Each janitor's closet shall have space for storage of buckets and vacuum.

(m) Mechanical, Electrical, and Telecommunications Rooms: Mechanical rooms shall accommodate space for equipment maintenance/repair access without having to remove other equipment. Mechanical, electrical and telecommunications rooms shall be keyed separately for access by Installation maintenance personnel. Filter changes and preventative maintenance shall be performed without requiring access to the bedrooms. First floor exterior access is required for centralized mechanical room. All telecommunications rooms shall be conditioned space. Telecommunications room will be provided on each floor in accordance with the latest Installation Information Infrastructure Architecture (I3A) guidance. Telecommunications room provides a demarcation point between the outside plant cable and the building telecommunications cabling. Refer to paragraphs 3.6 MECHANICAL REQUIREMENTS and 3.7 ELECTRICAL AND TELECOMMUNICATIONS REQUIREMENTS for additional information.

(n) Boot Wash: Provide an outdoor area for soldiers to rinse mud from field gear, boots and clothing. Boot wash stations shall be provided at main entrances. Each boot wash station shall consist of two freeze-proof hydrants located adjacent to a grated drain assembly complete with sand interceptor. Provide two spray nozzles on flexible hose per hydrant.

3.2.2.1.3. Company Operations Area

(a) Company Commander (CO): Provide a private administrative office. Provide space to accommodate scheduled GFGI furniture with adequate circulation as listed below.

- Space for U-shaped executive desk with worksurfaces 60 in. to 72in. wide x 30in. to 36in. deep with pedestal, 42 in. to 48in. wide x 15in. to 24in. deep and 60in. to 72in. x 18in. to 24in. deep with file pedestal.
- Space for overhead storage
- Space for one executive chair
- Space for one (1) 4-drawer lateral file , 16in. to 21in. wide x 15in. to 18in. deep with adjustable arm height.
- Space for two (2) guest chair

(b) Executive Officer (XO): Provide a private administrative office. Provide space to accommodate scheduled GFGI furniture with adequate circulation as listed below.

- Space for L-shaped executive desk with worksurfaces 60in. to 72in. wide x 30in. to 36in. deep with pedestal, 42in. to 48in. wide x 15in. to 24in. deep with file pedestal.
- Space for overhead storage
- Space for one ergonomic task chair
- Space for one (1) 4-drawer lateral files, 16in. to 21in. wide x 15in. to 18in. deep with adjustable arm height.
- Space for two (2) guest chairs

(c) Waiting Area: Provide common space and open office space for unit administrative functions, as well as centralized area for printers, fax machines and receptacles for waste and paper recycling. Provide space to accommodate scheduled GFGI furniture with adequate circulation as listed below.

- Two (2) open work areas with 48 NSF to include:
 - Space for a worksurface 60 in. to 72in. wide x 30in. to 36in. deep, a worksurface 29 in. to 48in. wide x 15in. to 24in. deep with file pedestal.
 - Space for overhead storage
 - Space for (1) ergonomic task chair, 16in. to 21in. wide x 15in. to 18in. deep with adjustable arm height.
- Space for four (4) guest chairs

(d) Operations Sergeant (OPS SGT): Provide a private administrative office. Provide space to accommodate scheduled GFGI furniture with adequate circulation as listed below.

- Space for L-shaped executive desk with worksurfaces 60in. to 72in. wide x 30in. to 36in. deep with pedestal, 42in. to 48in. wide x 15in. to 24in. deep with file pedestal.
- Space for overhead storage
- Space for one (1) ergonomic task chair, 16in. to 21in. wide x 15in. to 18in. deep with adjustable arm height.
- Space for two (2) 4-drawer lateral files, 16in. to 21in. wide x 15in. to 18in. deep with adjustable arm height.
- Space for two (2) guest chairs

(e) 1ST Sergeant (1ST SGT): Provide a private administrative office. Provide space to accommodate scheduled GFGI furniture with adequate circulation as listed below.

- Space for L-shaped executive desk with worksurfaces 60in. to 72in. wide x 30in. to 36in. deep with pedestal, 42in. to 48in. wide x 15in. to 24in. deep with file pedestal.
- Space for overhead storage
- Space for one (1) executive chair
- Space for two (2) 4-drawer lateral files, 16in. to 21in. wide x 15in. to 18in. deep with adjustable arm height.
- Space for two (2) guest chairs

(f) Men's Toilet/Shower: Provide one shower stall and toilet facilities to serve the public and administrative personnel assigned to company. Provide a dressing area with a built-in 18 inch wooden bench adjacent to the shower stall.

(g) Women's Toilet/Shower: Provide one shower stall and toilet facilities to serve the public and administrative personnel assigned to company. Provide a dressing area with a built-in 18 inch wooden bench adjacent to the shower stall.

(h) Multipurpose Space: Provide a room divided into three equal spaces with ceiling hung, moveable partitions. The moveable partitions shall have a minimum STC rating of 45. Each of the three spaces must have a separate exit. Each partitioned space is intended to provide adequate space for training of 30 persons in a three classroom arrangement or to support large gatherings of approximately 100 persons with the partitions retracted. Each partitioned space shall have a storage room with a net area of 80 square feet. Each storage room shall have lockable double doors. Square footage for storage rooms is included in the overall multipurpose room space allocation.

(i) Scrub Room: Provide ten rinsing stations in an indoor area for soldiers to rinse mud from field gear, boots and clothing. Each rinsing station shall include a combination laundry tray and deep laundry sink with hot and cold water, spray nozzle on flexible hose, drain and sand interceptor.

(j) Weapons Cleaning: Provide a work area with 30 inch deep, continuous built-in counter tops.

- (k) Arms Vault: Arms vault for storage of arms, ammunition, and explosives shall comply with Appendix G of AR 190-11, Physical Security of Arms, Ammunition, and Explosives. Arms vault door shall incorporate a steel dutch-door type day-gate with a steel issue shelf built into the lower leaf of the day-gate.
- (l) Company Supply: Provide storage space for company supplies and equipment, weapons, and consumable supplies. Shipping and receiving functions are performed from company supply area. Provide a pair of exterior doors in company supply for exterior vehicular access. A built-in lockable issue counter with laminated sliding glass window shall be integrated with a rolling shutter door between this room and the corridor. Issue counter opening shall be 36 inches wide and 42 inches high minimum.
- (m) Secure Storage: In the company supply area, provide a secure storage area for high value items of electronic equipment, e.g. night goggles. Secure storage area is separated from the company supply area with full height, security wire mesh partition with padlocked wire door. Secure storage shall have a minimum of six, 18 inch wide storage shelves, spaced at 15 inches on center vertically and capable of supporting a minimum of 20 pounds per linear foot. Total linear footage of storage shelves shall be three times the perimeter of the storage room.
- (n) Profile Recovery: This is an exercise area for injured trainees housing fitness equipment, e.g. treadmills, stationary bicycles, Stairmasters. All fitness equipment is GFGI
- (o) Covered Assembly Area: Provide an outside, sheltered space for equipment maintenance, weapons cleaning, and pre/post-training preparation and clean-up. Provide cabling/outlets for 3 telephones.

3.2.2.1.4. Space Allocation

B/COF MINIMUM SQUARE FOOTAGE REQUIREMENTS				
NET SQUARE FEET (NSF)				
	1ST FLOOR	2ND FLOOR	3RD FLOOR	
SLEEPING UNIT – 50 UNITS PER FLOOR				
BEDROOM	216	216	216	
BATHROOM	31	31	31	
ENTRY	AS NEEDED	AS NEEDED	AS NEEDED	
UTILITY CLOSET	AS NEEDED	AS NEEDED	AS NEEDED	
COMMON AREA				
LOBBY AND VESTIBULES	AS NEEDED – MINIMUM 10'-0" WIDE			
STAIR	AS NEEDED – STAIRS SHALL BE MINIMUM 4'-6" WIDE			
CORRIDORS AND VESTIBULES	AS NEEDED - MINIMUM 6'-0" WIDE			
DRILL INSTRUCTOR (DI) OFFICE	320	320	320	
CQ STATION	AS NEEDED			
COMPUTER LEARNING CENTER WITH STORAGE	900	900	900	
DAY ROOM WITH STORAGE	900	900	900	
LAUNDRY 1 PER FLOOR	AS NEEDED			
LUGGAGE STORAGE 2 PER FLOOR AT 164 NSF EACH	160/160	160/160	160/160	
JANITOR 2 PER FLOOR	20SF MIN. EACH			

MECHANICAL, TELECOMMUNICATIONS AND ELECTRICAL	AS NEEDED			
COMPANY OPERATIONS AREA				
COMPANY COMMANDER (CO)	150			
EXECUTIVE OFFICER (XO)	110			
WAITING AREA	266			
OPS SGT	110			
1ST SGT	120			
MEN'S TOILET	AS NEEDED			
WOMEN'S TOILET	AS NEEDED			
VENDING	AS NEEDED			
MULTIPURPOSE SPACE WITH STORAGE	1,700			
SCRUB ROOM	246			
WEAPONS CLEANING	120			
ARMS VAULT	200			
COMPANY SUPPLY	280			
SECURE STORAGE	100			
PROFILE RECOVERY	350			
COVERED ASSEMBLY AREA	3,500			

3.2.3. NOT USED

3.2.4. NOT USED

3.2.5. CCP

Central cooling plant building shall provide adequate space and clearance for equipment maintenance and repair.

3.2.6. LEB

Provide 2,000 gross square feet lawn maintenance equipment storage building. LEB shall be divided with partitions into four equal spaces, to provide an individually securable storage space with separate access for each B/COF. Access to each individual storage space shall be through a lockable overhead coiling door minimum eight feet wide by seven feet high.

3.3. SITE REQUIREMENTS

3.3.1. Walks: Provide pedestrian walks within the designated construction area and connect to existing sidewalks, where applicable.

(a) Sidewalks shall be a minimum of 6 feet wide. Troop formation sidewalks shall be a minimum of 15 feet wide. Troop formation sidewalks that are also designed to support emergency and service vehicle traffic shall be a minimum of 20 feet wide per NFPA requirements. Walks paralleling buildings shall be located beyond the eave drip line and at least 5 feet from the foundation.

(b) Non-vehicular pedestrian and troop formation sidewalks shall be constructed of Portland Cement Concrete and have a minimum nominal thickness of 4 inches. Joint patterns shall be designed in accordance with American

Association of State Highway and Transportation Officials (AASHTO) standards and shall be uniform and symmetrical. The length to width ratio shall not exceed 1.25 for non-reinforced pavements.

(c) Troop formation sidewalks designed to support emergency and service vehicle traffic will be considered roadway pavements and shall be designed to meet AASHTO standards. Vehicular supported walks shall be constructed of Portland Cement Concrete and shall have a minimum nominal thickness of 7 inches. Joints shall be designed in accordance with AASHTO standards and shall be uniform and symmetrical. The length to width ratio shall not exceed 1.25 for non-reinforced pavements.

3.3.2. Physical Fitness Training Areas

Outdoor training areas, particularly those that are needed for physical fitness, should be located to the interior areas of the AIT Complex. The minimum mandatory exterior training areas for the complex include one running track per complex, one physical training (PT) pit per B/COF and four 4-station climbing bar sets per B/COF.

3.3.2.1. Running Track: Provide one closed, oval or round shaped, 1/4 mile running track. The track must be a separate stand alone feature, not incorporated into other site features, such as roads or walks. The entire track must be observable from one central location to allow minimal drill instructor oversight. The track shall be constructed of a synthetic sports surface material, as specified in Specification Section 02 83 30 SYNTHETIC SPORTS SURFACE (located in Attachment A). Track width shall be 15 feet. Running lanes are not required. Surface and subsurface drainage shall be designed for the track. No standing water shall be allowed on the track. Track lighting level shall be a minimum of 3 foot-candles and shall be switch operated.

3.3.2.2. PT Pits: Provide one PT Pit and four 4-station climbing bars for each B/COF. Refer to Attachment A-Drawings for physical training equipment. Each pit shall be a minimum of 18,500 square feet. Square pits are desired, but pits may be adjusted to meet site conditions. The pits shall be located to the rear of each B/COF and can either be stand alone facilities or located within the interior of the track. Separation of PT pits located within the track shall be visibly defined. PT pits will be used for hand to hand combat drills, as well as, calisthenics. The PT pit shall be constructed of a durable, low maintenance surface, such as a 2 inch extruded monofilament synthetic turf surface with a sand and rubber infill or a similar application. An option that may be considered is artificial "field turf". Surface and subsurface drainage shall be designed for the PT pits. No standing water shall be allowed on the PT pits. No canopy coverings may be provided over the PT pits, and no fences shall be provided. Pit lighting level shall be a minimum of 3 foot-candles and shall be switch operated.

3.3.3. Not Used

3.3.4. Not Used

3.4. ARCHITECTURAL REQUIREMENTS

3.4.1. Hardware

(a) Not Used

(b) Finish Hardware: All hardware shall be consistent and shall conform to ANSI/BMHA standards for Grade 1. All requirements for hardware keying shall be coordinated with the Contracting Officer. Hardware finish shall conform to ANSI/BHMA A156 18; finish shall be Code # 625 or 629. Extension of the existing installation keying system shall be provided. Installation keying system is a grand master keying system. Locksets shall have interchangeable cores. Cores shall have no fewer than seven pins. Cores for locksets other than those for mechanical, electrical, and telecommunications rooms shall be manufactured by BESTLOCK Corporation. Locksets for mechanical, electrical and telecommunications rooms only shall be keyed to the existing Installation utilities master keying system. Deadbolt locks shall be installed on mechanical, electrical and telecommunications rooms keyed to the Installation keying system. Disassembly of knob or lockset shall not be required to remove core from lockset. All locksets and exit devices shall accept same interchangeable cores. Plastic cores are unacceptable. Door hardware and security requirements must be coordinated with the functional requirements, the room-by-room criteria, and the electrical security/fire alarm system requirements of this document. Provide all hardware necessary to meet the requirements of applicable codes for fire doors and exit doors. Provide closers for all doors opening to corridors and as required by codes.

3.4.2. Special Acoustical Requirements

3.4.2.1. Exterior walls and roof/floor/ceiling assemblies, doors, windows and interior partitions shall be designed to provide for attenuation of external noise sources such as airfields in accordance with applicable criteria. Provide sound insulation to meet a minimum rating of STC 42 at walls and floor/ceiling assemblies. At interior doors provide solid core wood doors in metal frame with sound insulation to meet a minimum rating of STC 33. In addition to the sound insulation required, video teleconferencing areas shall meet a Noise Criteria (NC) 30 rating in accordance with ASHRAE Fundamentals Handbook. Provide sound insulation to meet a minimum rating of STC 50/IIC 55 at floors separating sleeping spaces.

3.4.2.2. Sound conditions and levels for interior spaces, due to the operation of mechanical and electrical systems and devices, shall not exceed levels as recommended by ASHRAE handbook criteria. Provide acoustical treatment for drain lines and other utilities to prevent noise transmission into the interior of sleeping units.

3.4.3. Exterior Design Objectives

3.4.3.1. Exterior Walls: Provide durable materials.

3.4.3.2. Roof System: Minimum roof slope for membrane roof systems shall be 1/4 inch per foot. Minimum roof slope for pitched roof systems shall be 3 inches per foot. Membrane roof systems shall be fully adhered. Structural standing seam metal roofs shall comply with the requirements of ASTM E 1592. Roof system shall be Underwriters Laboratory (UL 580 Class 90) rated or Factory Mutual Global (FM) I-90 rated. Roof system shall comply with applicable criteria for fire rating.

(a) Roof Mounted Equipment: For roof mounted equipment, provide permanent access walkways and platforms to protect roof. Roof mounted equipment on pitched roof systems is unacceptable. Roof mounted equipment on membrane roof systems shall be completely screened by the roof parapet.

(b) Roof access from building exterior is prohibited.

3.4.3.3. Trim and Flashing: Gutters, downspouts, and fascias shall be factory pre-finished metal and shall comply with SMACNA Architectural Sheet Metal Manual.

3.4.3.4. Bird Habitat Mitigation: The Contractor shall provide details in the design necessary to eliminate the congregating and nesting of birds at, on, and in the facility.

3.4.3.5. Exterior Doors and Frames:

(a) Main Entrance Doors: Aluminum storefront doors and frames with Architectural Class 1 anodized finish, fully glazed, with medium or wide stile for entry into lobbies or corridors. Provide doors complete with frames, framing members, subframes, transoms, sidelights, trim, applied muntins, and accessories. Framing systems shall have thermal-break design. Storefront systems shall comply with wind-load requirements of applicable codes and criteria and shall comply with the requirements of UFC 4-010-01.

(b) Other Exterior Doors: Exterior doors and frames opening to spaces other than corridors or lobbies shall be galvanized insulated hollow metal and comply with ANSI A250.8/SDI 100. Doors shall be heavy duty (grade 2) insulated with 18-gage steel cladding; top edge closed flush; A60 galvanized. Frames shall be 12-gauge, with continuously welded mitered corners and seamless face joints. Doors and frames shall be constructed of hot dipped zinc coated steel sheet, complying with ASTM A653, Commercial Steel, Type B, minimum A40 coating weight; factory primed. Fire-rated openings shall comply with applicable codes, and the requirements of the labeling authority. Door and frame installation shall comply with applicable codes and criteria including UFC 4-010-01.

3.4.3.6. Exterior Windows: Provide insulated, high efficiency window systems, with thermally broken frames complying with applicable codes and criteria including UFC 4-010-01. Curtain wall systems shall be capable of withstanding area wind loads, thermal and structural movement required by location and project requirements, and shall comply with applicable codes and criteria including UFC 4-010-01.

3.4.3.7. Exterior Louvers: Exterior louvers shall have bird screens and shall be designed to exclude wind-driven rain. Exterior louvers shall be made to withstand wind loads in accordance with the applicable codes. Wall louvers shall bear the Air Movement & Control Association (AMCA) International certified ratings program seal for air performance and water penetration in accordance with AMCA 500-D and AMCA 511. Louver finish shall be factory applied.

3.4.4. Building Interior

Interior Design Objectives: Provide durable materials and furnishings that are easily maintained and replaced. Maximize use of daylighting. Provide interior surfaces that are easy to clean and light in color. Design B/COF barracks area with a residential ambience. Design B/COF company operations area with an office ambience.

3.4.4.1. Signage: At each sleeping unit, provide two room number and changeable two-line message strip signs, one on each side of entry door. Changeable message strip signs shall be of same construction as standard room signs to include a clear sleeve that will accept a paper or plastic insert with identifying changeable text. The insert shall be prepared typeset message photographically enlarged to size and mounted on paper card stock.

3.4.4.2. Bulletin Boards: In each B/COF provide one centrally located bulletin board per floor. Each bulletin board shall be 4 feet high and 6 feet wide and shall have a header panel and lockable, glazed doors.

3.4.4.3. Corner Guards: Provide surface mounted, high impact resistant, integral color, snap-on type resilient corner guards, extending from floor to ceiling for wall and column outside corners in high traffic areas. Factory fabricated end closure caps shall be furnished for top and bottom of surface mounted corner guards.

3.4.4.4. Chair Rail: Chair rails shall be installed in areas prone to hi-impact use, such as corridors and lobby seating areas.

3.4.4.5. Casework: Provide cabinets complying with Architectural Woodwork Institute Quality Standards. Countertops shall have waterfall front edge and integral coved backsplash.

3.4.4.6. Window Treatment: Provide horizontal mini blinds at all exterior windows. Uniformity of window covering color and material shall be maintained to the maximum extent possible throughout each building. Blinds in B/COF barracks area shall be room darkening mini blinds.

3.4.4.7. Toilet Accessories: Furnish and install the items listed below and all other toilet accessories necessary for a complete and usable facility. All toilet accessories shall be Type 304 stainless steel with satin finish.

(a) Toilets/Shower: Accessories shall include the following items.

- Glass mirrors on stainless steel frame and shelf – at each lavatory
- Hands free liquid soap dispenser – at each lavatory
- Hands free paper towel dispenser at each lavatory/toilet area
- Waste receptacle – recessed mounted at each lavatory/toilet area
- Sanitary napkin disposal at each female toilet
- Toilet paper dispenser – lockable multiple roll at each toilet
- Sanitary toilet seat cover dispenser – at each toilet stall
- Grab bars – as required by ADA
- Shower curtain rod - extra heavy duty
- Shower curtain – white anti-bacterial nylon/vinyl fabric shower curtain
- Soap dish – in shower
- Robe hook – adjacent to shower enclosure entry

(b) Sleeping Unit Bathroom: Accessories shall include the following items.

- Two heavy duty towel bars – minimum 24 inches wide each
- Mirrored medicine cabinet
- Soap dish – in shower
- Combination soap dish/toothbrush holder – at each lavatory
- Double robe hook - on inside of bathroom door
- Toilet paper holder
- Shower curtain rod - extra heavy duty
- Shower curtain – white anti-bacterial nylon/vinyl fabric shower curtain
- Drill Instructor Toilet/Shower: Accessories shall include the following items.
- Glass mirrors on stainless steel frame and shelf – at each lavatory

- Hands free liquid soap dispenser – at each lavatory
- Hands free paper towel dispenser
- Waste receptacle - recessed mounted
- Toilet paper dispenser – lockable multiple roll at each toilet
- Shower curtain rod - extra heavy duty
- Shower curtain – white anti-bacterial nylon/vinyl fabric shower curtain
- Soap dish – in shower
- Robe hook – in shower dressing area

3.4.4.8. Fire Extinguisher Cabinets and Fire Extinguisher Mounting Brackets: Furnish and install fire extinguisher cabinets and fire extinguisher Mounting brackets as required by applicable codes and criteria. Furnish a list of installed fire extinguisher cabinets and mounting brackets (including location, size and type) to the Contracting Office Representative.

(a) Toilets/Shower: Accessories shall include the following items.

- Glass mirrors on stainless steel frame and shelf – at each lavatory
- Hands free liquid soap dispenser – at each lavatory
- Hands free paper towel dispenser at each lavatory/toilet area
- Waste receptacle – recessed mounted at each lavatory/toilet area
- Sanitary napkin disposal at each female toilet
- Toilet paper dispenser – lockable multiple roll at each toilet
- Sanitary toilet seat cover dispenser – at each toilet stall
- Grab bars – as required by ADA
- Shower curtain rod - extra heavy duty
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- Toilet paper holder
- Shower curtain rod - extra heavy duty
- Shower curtain – white anti-bacterial nylon/vinyl fabric shower curtain
- Drill Instructor Toilet/Shower: Accessories shall include the following items.
- Glass mirrors on stainless steel frame and shelf – at each lavatory
- Hands free liquid soap dispenser – at each lavatory
- Hands free paper towel dispenser
- Waste receptacle - recessed mounted
- Toilet paper dispenser – lockable multiple roll at each toilet
- Shower curtain rod - extra heavy duty
- Shower curtain – white anti-bacterial nylon/vinyl fabric shower curtain
- Soap dish – in shower
- Robe hook – in shower dressing area

3.4.5. Finishes

3.4.5.1. Paint

(a) All paints used shall be listed on the "Approved Product List" of the Master Painters Institute (MPI). Application criteria shall be as recommended by MPI guide specifications for the substrate to be painted and the environmental conditions existing at the project site.

(b) Exterior surfaces, except factory pre-finished material or exterior surfaces receiving other finishes shall be painted a minimum of one prime coat and two finish coats. Paints having a lead content over 0.06 percent by weight of nonvolatile content are unacceptable. Paints containing zinc-chromate, strontium-chromate, mercury or mercury compounds, confirmed or suspected human carcinogens shall not be used on this project. Exterior paints and coating products shall be classified as containing low volatile organic compounds (VOCs) in accordance with MPI criteria. Application criteria shall be as recommended by MPI guide specifications. Provide an MPI Gloss Level 5 Finish (semi-gloss), unless otherwise specified.

(c) Interior surfaces, except factory pre-finished material or interior surfaces receiving other finishes, shall be painted a minimum of one prime coat and two finish coats. Paints having a lead content over 0.06 percent by weight of nonvolatile content are unacceptable. Paints containing zinc-chromate, strontium-chromate, mercury or mercury compounds, confirmed or suspected human carcinogens shall not be used on this project. Interior paints and coating products shall contain a maximum level of 150 grams per liter (g/l) of VOCs for non-flat coatings and 50 g/l of VOCs for flat coatings. Provide an MPI Gloss Level 5 Finish (semi-gloss) in wet areas and a flat finish in all other areas.

3.4.5.2. Minimum Interior Finishes-General

(a) Designers are not limited to finishes listed in the following INTERIOR FINISHES table(s) and are encouraged to offer higher quality finishes.

(b) Wall, ceiling and floor finishes and movable partitions shall conform to the requirements of the IBC, NFPA and UFC 3-600-01 Fire Protection Engineering for Facilities. Where code requirements conflict, the most stringent code requirement shall apply.

(c) Carpet shall not be used as a floor finish in the B/COF. Vinyl composition tile (VCT) shall be minimum 1/8 inch thick, conforming to ASTM F 1066, Class 2, through pattern tile, Composition 1, asbestos free, with color and pattern uniformly distributed throughout the thickness of the tile.

(d) Walls: All wall finish shall be minimum 5/8" painted gypsum board, except where stated otherwise. All gypsum board shall achieve a score of 10, the highest level of performance for mold resistance under the ASTM D 3273 test method. All gypsum board shall be transported, handled, stored and installed in accordance with the GYPSUM ASSOCIATION – Guidelines For Prevention Of Mold Growth On Gypsum Board (GA-238-03). Use impact resistant gypsum board in corridors, storage rooms, stairwells and activity rooms and centralized laundries (if centralized laundries are required by RFP).

(e) All ceiling finishes shall be minimum 5/8" painted gypsum board, except where stated otherwise. All gypsum board shall achieve a score of 10, the highest level of performance for mold resistance under the ASTM D 3273 test method. All gypsum board shall be transported, handled, stored and installed in accordance with the GYPSUM ASSOCIATION – Guidelines For Prevention Of Mold Growth On Gypsum Board (GA-238-03).

3.4.5.3. B/COF Interior Finishes

BCOF MINIMUM INTERIOR FINISHES																	
	FLOORS					BASE			WALLS				CEILING			REMARKS	
	RESILIENT FLOORING	PORCELAIN OR QUARRY TILE	CERAMIC TILE	RECESSED ENTRY MAT	SEALED CONCRETE	RESILIENT BASE	PORCELAIN OR QUARRY BASE	CERAMIC BASE	GYPSUM WALL BOARD - PAINT	REINFORCED, FULLY GROUTED CMU OR CONCRETE	CERAMIC TILE	INSULATED STORE FRONT SYSTEM, LAMINATED GLASS	GYPSUM WALLBOARD	ACOUSTICAL CEILING TILE	REINFORCED CONCRETE	MINIMUM HEIGHT 8' UNLESS STATED OTHERWISE	
BEDROOM	•					•			•				•			9'-0"	

BATHROOM																		NOTES 1 AND 4
ENTRY	.																	
UTILITY ROOM																		
LOBBY AND VESTIBULES		.																
STAIR	.																	NOTE 8
CORRIDORS		.															9'-0"	
DI OFFICE	.																	
DI TOILET																		NOTES 1 AND 4
CQ STATION		.																
COMPUTER LEARNING CENTER	.																	NOTE 3
DAY ROOM To Include Storage	.																	NOTE 3 AND 5
LAUNDRY		.																NOTES 4 AND 10
LUGGAGE STORAGE	.																	
GENERAL STORAGE	.																	
JANITOR			.															SEE NOTE 2
MECH																		NOTES 7 AND 10
TELECOM	.																10'-0"	
ELEC																		
CO	.																	NOTE 6
XO	.																	
WAITING AREA	.																9'-0"	
OPS SGT	.																	
1ST SGT	.																	
MEN'S RESTROOM			.															NOTES 1 AND 10
WOMEN'S RESTROOM			.															NOTES 1 AND 10
MULTI PURPOSE SPACE	.																	NOTE 3
SCRUB ROOM																		NOTE 10
WEAPONS CLEANING																		
ARMS VAULT																		
COMPANY SUPPLY	.																	
SECURE STORAGE	.																	
PROFILE RECOVERY	.																	NOTE 3
COVERED ASSEMBLY AREA																		NOTE 9
1. ALL WET WALLS IN TOILET ROOMS SHALL HAVE A 4' HIGH CERAMIC TILE WAINSCOT. ALL SHOWERS SHALL HAVE FULL HEIGHT TILE WALLS. VANITY TOPS SHALL BE CAST 100 PERCENT ACRYLIC POLYMER SOLID SURFACING MATERIAL WITH WATERFALL FRONT EDGE AND INTEGRAL COVED BACKSPLASH.																		
2. WALLS ADJACENT TO JANITOR'S SINK SHALL HAVE A 4' 0" HIGH CERAMIC WAINSCOT.																		
3. USE SAME FINISHES IN ADJACENT CLOSET OR STORAGE ROOM																		
4. ALL COUNTERS SHALL HAVE A MINIMUM OF 4" HIGH BACKSPLASH																		
5. IN VENDING OR RECYCLABLES STORAGE ARE, MATCH FLOORING, WALL, AND CEILING FINISHES TO THOSE OF ADJACENT AREA.																		
6. EXTEND PARTITIONS TO DECK. PROVIDE SOUND INSULATION TO MEET A MINIMUM RATING AT DOORS AND WALLS OF STC 50.																		
7. CEILING MAY BE PAINTED EXPOSED STRUCTURE IF ALLOWED BY APPLICABLE CODE.																		
8. RISERS SHALL BE PAINTED STEEL. STAIR LANDINGS AND TREADS SHALL HAVE RESILIENT FLOORING OR SEALED CONCRETE. PROVIDE TREADS WITH SLIP RESISTANT NOSING																		
9. PAINT STRUCTURE.																		
10. PROVIDE FLOOR DRAIN IN CENTER OF ROOM. THIS DOES NOT APPLY TO LIVING UNIT MECHANICAL CLOSETS.																		

3.4.5.4. Not Used

3.4.5.5. Not Used

3.4.5.6. CCP Interior Finishes

Floors shall be sealed concrete with a resilient base. Walls shall be painted impact resistant gypsum wallboard.

3.4.5.7. LEB Interior Finishes:

Floors shall be sealed concrete with a resilient base. Walls shall be painted impact resistant gypsum wallboard.

3.4.5.8. B/COF Furniture Chart

B/COF FURNITURE CHART		
Description	Comments	Furniture Required
Executive Office (CO)	Private Office	U-shaped executive desk with two pedestals, hutch, one 4-drawer lateral file, two guest chairs, one executive chair
Executive Office (XO)	Private Office	L-shaped double pedestal desk unit, hutch, one 4-drawer lateral file, two guest chairs, one task chair
Office 1 (1 ST SGT)	Private Office	L-shaped double pedestal desk unit, hutch, two 4-drawer lateral files, two guest chairs, one executive chair
Office 2 (OPS SGT)	Private Office	L-shaped double pedestal desk unit, hutch, two 4-drawer lateral files, two guest chairs, one task chair
DI Office	48 NSF Open Workstations, Waiting Area	Three systems furniture workstations with work surfaces, file pedestals, and overhead storage, three task chairs, four guest chairs
Waiting Area	48 NSF Open Workstations, Waiting Area	Two systems furniture workstations with work surfaces, file pedestals, and overhead storage, two task chairs, two guest chairs, three waiting area chairs, one side table
Computer Learning Center	Classroom	24 computer carrels, one storage cabinet, 24 task chairs
Multi-Purpose	Classroom	100 tablet-arm chair desks, movable partitions to divide large classroom space into three equally-sized spaces
Company Supply	Storage	One systems furniture workstation with work surfaces, file pedestals, and overhead storage, one task chair, 19 heavy-duty shelving units
Laundry	Utilitarian	Three folding/hanging tables
Lobby-1st floor	CQ and Building Reception Area	One reception center with task chair, six guest chairs
Profile Recovery	Exercise Room	Exercise equipment
Day Room		7-seat upholstered arrangement with side tables, 36" round table with four guest chairs, entertainment system storage, pool table and/or table tennis
Lobby - 2nd/3rd floor	Waiting Area	7-seat upholstered arrangement with side tables
Sleeping Module	Dormitory Room	Two beds, two nightstands, two desks with hutch, two desk chairs, two lamps

3.4.5.9. Not Used

3.4.5.10. Not Used

3.5. STRUCTURAL REQUIREMENTS

Design and construct as a complete system in accordance with APPLICABLE CRITERIA.

3.5.1. Live Loads: Design live loads shall be per the IBC but not lower than the following minimums.

- (a) Elevated slabs 60 pounds per square foot (psf)
- (b) Slab on grade 150 psf
- (c) Centralized laundry area 150 psf, but not less than actual equipment loads.

3.6. COMPLIANCE WITH THE ENERGY POLICY ACT OF 2005 (EPACT 2005)

3.6.1. The building, including the building envelope, HVAC systems, service water heating, power, and lighting systems shall be designed to achieve an energy consumption that is at least 30% below the consumption of a baseline building meeting the minimum requirements of ANSI/ASHRAE/IESNA Standard 90 (see paragraph 5.9 Energy Conservation)

3.6.2. Target Energy Consumption Budget

The target energy consumption budget (excluding plug loads) for this facility located in Climate Zone 4A is 52 kBtu per ft² per year or less.

3.6.3. Prescriptive Path (Use of Technology Solution Set)

The technology solution set shown in the table below contributes to the achievement of the above energy performance and life cycle cost effectiveness requirements for an AIT B/COF facility in the indicated DOE climatic zone.

Climate Zone 4A, Prescriptive Technology Solution Table

Item	Component	30% Solution
Roof	Attic	R-50
	Surface reflectance	0.27
Walls	Light Weight Construction	R-20
Exposed Floors	Mass	R-20
Slabs	Unheated	NR ⁽²⁾
Doors	Swinging	U-0.70
	Non-Swinging	U-1.45
Infiltration		0.25 cfm/ft ² @ 75 Pa ⁽³⁾
Vertical Glazing	Window to Wall Ratio (WWR)	10% - 20%
	Thermal transmittance	U-0.45
	Solar heat gain coefficient (SHGC)	0.31
Interior Lighting	Lighting Power Density (LPD)	0.9 W/ft ²
	Ballast	Electronic ballast
HVAC	Air Conditioner	4-Pipe Fan Coil with central chiller and boiler plus

		DOAS ⁽⁴⁾ with 14.0 SEER DX coil (3.52 COP) and HHW coil on central boiler
		SAT control 55°F – 62°F with OAT 75° – 54°F
	Gas Furnace	none
	ERV	70% - 75% sensible effectiveness
Economizer		no
Ventilation	Outdoor Air Damper	Motorized control
	Demand Control	NR
	Laundry Room	Decoupled ⁽⁵⁾
Ducts	Friction Rate	0.08 in. w.c./100 feet
	Sealing	Seal class B
	Location	Interior only
	Insulation level	R-6 ⁽⁶⁾
Service Water Heating	Gas storage	90% E _t

Notes (#):

- (1) NOT USED
- (2) NR means there is no requirement or recommendation for a component in this climate.
- (3) Increased Building Air tightness. Building air leakage (measured in cfm/ft²) is the average volume of air (measured in cubic feet per minute) that passes through a unit area of the building envelope (measured in square feet) when the building is maintained at a specified internal pressure (measured in Pascals). Testing requirements are specified in Chapter 5..
- (4) Dedicated Outdoor Air System. A central dedicated outdoor air system (DOAS) providing the following:
- outside air for building indoor air quality and humidity control
 - make-up air for bathroom and kitchen exhausts
 - Building pressurization to prevent infiltration which allows for reduction of heating/cooling and moisture loads on the system.

NOTE: The Central DOAS does not provide sensible heating or cooling. Sensible loads are provided by a complementing heating and cooling system

(5) **Decoupling exhaust and supply systems for laundry rooms.** To reduce unneeded energy use for heating and cooling of the make-up air and for air transportation of supply and exhausted air from the dryers, laundry exhaust and supply systems are separated in the efficient building model from the rest of the building exhaust and supply systems. Laundry exhaust system and corresponding make-up systems operate only when dryers are operating.

(6) The duct and pipe insulation values are from the ASHRAE Advanced Energy Design Guide for Small Offices.

All design features of this EPACT 2005 compliant B/COF not described above will be in accordance with the minimum requirements of ANSI/ASHRAE/IESNA Standard 90.1-2004. including conformance with paragraph 5.9.2, which requires purchase of Energy Star and FEMP designated products.

3.6.4. Compliance Path

When the “Compliance Path” is selected, the facility design shall include a uniquely developed technology solution set which can be shown by the design analysis (using facility energy simulation software) not to exceed the target energy consumption budget stated in 3.3.2 above and meet all the criteria in the DOE interim final rule: “Energy

Conservation Standards for New Federal Commercial and Multi-Family High-Rise Residential Buildings and New Federal Low-Rise Residential Buildings”.

3.6.5. Schedules

If a unique technology solution set method of compliance is chosen then the following facility schedules must be used in all facility energy simulations for purposes of showing compliance with 3.6.4. Additionally, for simulation of a baseline building model, the “baseline values” for each component shall be as per ASHRAE Standard 90.1-2004 Building Envelope Requirements table for applicable climate zone and residential construction.

AIT B/COF Common Area Internal Load Schedules

Hr	Occupancy			Lighting			Washer/Dryer Use			Washer SHW		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1-6	0.00	0.00	0.00	0.30	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00
7-10	0.20	0.20	0.20	0.30	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00
11-18	0.00	0.00	0.00	0.30	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.80	0.80	0.80	0.00	0.00	0.00	0.00	0.00	0.00
20-21	0.20	0.20	0.20	0.80	0.80	0.80	0.50	0.50	0.50	0.50	0.50	0.50
22-23	0.40	0.40	0.40	0.80	0.80	0.80	1.00	1.00	1.00	1.00	1.00	1.00
24	0.20	0.20	0.20	0.80	0.80	0.80	0.50	0.50	0.50	0.50	0.50	0.50
Peak	5 occ/floor			1.0 W/ft ² (10.8 W/m ²)			8.4 kW/floor			53.3 gal/hr/flr (202 L/hr/flr)		

AIT B/COF Apartment Unit Internal Load Schedules

Hr	Occupancy			Lighting			Plug Loads			Service Hot Water		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1-5	0.80	0.75	0.75	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.00	0.00
6	0.70	0.65	0.75	0.40	0.30	0.20	0.20	0.20	0.20	0.10	0.10	0.10
7	0.60	0.60	0.70	0.70	0.50	0.30	0.40	0.35	0.20	0.40	0.40	0.40
8	0.50	0.50	1.00	0.50	0.50	0.50	0.40	0.40	0.40	0.20	0.20	0.20
9	0.25	0.25	0.00	0.20	0.20	0.20	0.30	0.40	0.40	0.00	0.00	0.00
10-17	0.20	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.00	0.00	0.00
18	0.30	0.30	0.30	0.50	0.50	0.50	0.50	0.50	0.50	0.10	0.10	0.10
19	0.50	0.30	0.30	0.70	0.70	0.70	0.50	0.50	0.50	0.10	0.10	0.10
20	0.50	0.50	0.50	0.70	0.70	0.70	0.60	0.50	0.50	0.10	0.10	0.10
21	0.70	0.50	0.50	0.70	0.70	0.70	0.60	0.50	0.50	0.00	0.00	0.00
22	0.70	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.00
23	0.80	0.75	0.75	0.40	0.40	0.40	0.40	0.50	0.50	0.00	0.00	0.00
24	0.80	0.75	0.75	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.00	0.00
Peak	2 occ/unit			1.1 W/ft ² (10.8 W/m ²)			1.7 W/ft ² (18 W/m ²)			40 gal/hr (114 L/hr)		

AIT B/COF Apartment Unit Internal Load Schedules

Hr	Refrigerator			Range and Oven		
	Wk	Sat	Sun	Wk	Sat	Sun
1-6	1.00	1.00	1.00	0.01	0.01	0.01
7-16	1.00	1.00	1.00	0.04	0.04	0.04
17-18	1.00	1.00	1.00	0.05	0.05	0.05
19-20	1.00	1.00	1.00	0.11	0.11	0.11

Hr	Refrigerator			Range and Oven		
21-23	1.00	1.00	1.00	0.10	0.10	0.10
24	1.00	1.00	1.00	0.03	0.03	0.03
Peak	76.36 W/unit			68.95 W/unit		

AIT B/COF Apartment Unit Thermostat Set-Point Schedules

Hr	Heating (°F)			Heating (°C)			Cooling (°F)			Cooling (°C)		
<input type="checkbox"/>	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1-24	68	68	68	20	20	20	75	75	75	24	24	24

AIT B/COF Unoccupied Zones (ie stairwells, mechanical rooms) Thermostat Set-Point Schedules

Hr	Heating (°F)			Heating (°C)		
<input type="checkbox"/>	Wk	Sat	Sun	Wk	Sat	Sun
1-24	55	55	55	12.8	12.8	12.8

3.7. MECHANICAL REQUIREMENTS

3.7.1. Plumbing

3.7.1.1. Domestic water heating system shall be sized based on 20 gallons of 110 deg F hot water consumption per occupant during morning peak period. Peak period duration shall be 30 minutes (10 minute duration for shower and lavatory use per occupant per sleeping unit plus a 10 minute transition period). Hot water storage capacity shall be based on 75% usable storage and a storage temperature of 140 deg F.

3.7.1.2. Domestic hot water pipe sizing shall be based on all showers flowing simultaneously at a rate of 2.0 gpm per shower. Waste stacks, building waste drains, and lift stations shall be sized with consideration to the increased flow rates as well.

Maximum plumbing fixture flow rates shall be as follows:

Water closets: 1.28 gallons per flush

Showers: 2.0 gpm

Bathroom sinks: 1.0 gpm

Kitchen sinks: 1.5 gpm

Janitor sinks: 2.0 gpm

3.7.1.3. Provide scrub room and boot wash drains with easily maintainable sand interceptors.

3.7.1.4. Laundry facilities shall be considered commercial laundries with respect to the International Plumbing Code (IPC) and shall be provided with easily maintainable solids interceptor(s) in accordance with the IPC. If dryer vents are manifolded to a common exhaust, provide an easily accessible means of cleanout.

3.7.1.5. The CCP shall have all necessary plumbing to allow for make-up water, maintenance, leakage and condensate drainage, blowdown drainage, and anything else necessary for a fully functional and maintainable CCP.

3.7.2. Heating, Ventilating and Air-Conditioning (HVAC)

3.7.2.1. All sleeping unit HVAC units shall be located in utility closets accessible only through a corridor access door. Utility closet doors shall be sized for ease of service and maintenance of HVAC units. Access for maintenance shall not require entry into the sleeping unit. Air filters shall be located in duct mounted filter boxes within the utility closet.

3.7.2.2. Each sleeping unit shall be positively ventilated using dedicated outdoor air units. Dedicated outdoor air units (DOAUs) shall continuously supply dehumidified, tempered air ducted directly to each sleeping unit from DOAU. Supply air conditions from DOAU shall be between 68 and 75 degree F dry bulb and no greater than 48 degree F dew point. Supply quantity shall be 40 cfm per sleeping unit. Sleeping unit exhaust shall be 25 cfm continuous through a bathroom exhaust. (Note: This exceeds ASHRAE 62.1 but provides compliance with IMC chapter 4 and maintains slight building positive pressurization with respect to dwelling unit exhaust rate of 25 cfm). DOAU unit shall be direct expansion (DX) type and cooling/dehumidification shall be available 24/7/365. Refer to chapter 6 for site specific constraints. The number of exhaust fans and DOAUs shall be the same, and exhaust fans and DOAUs shall be arranged for and shall include exhaust air energy recovery. Exhaust and DOAU systems shall be provided with variable frequency drives (VFDs) and shall be provided with a control logic that provides reduced ventilation rates during periods of low interior humidity and still meet minimum ASHRAE 62.1 requirements.

3.7.2.3. B/COF corridors shall be ventilated per ASHRAE 62.1 by supply from the dedicated outdoor air unit(s).

3.7.2.4. Sleeping unit room temperature control shall be through the direct digital control (DDC) system. Each sleeping unit shall have a heating/cooling unit. Occupant control will include on/off fan selection and an occupant temperature setpoint adjustment mechanism that allows +/- 2 degrees F of adjustment from the DDC programmed set points of 70 degrees F heating and 75 degrees F cooling. Additionally the DDC controls shall monitor each sleeping unit for sub-cooling. The DDC system shall record an alarm event if the space temperature drops below 71 degrees F (adjustable) when the outside air is greater than 85 degrees F (adjustable). Occupant control shall also include ability to select heating or cooling mode. HVAC system shall be able to provide for year round heating or cooling in individual sleeping units as selected by the occupants.

3.7.2.5. Not Used

3.7.2.6. The CCP shall be designed to support the peak block load of all connected buildings. If heating is provided for domestic water or building heat, low temperature hot water shall be provided. Distributed steam or high temperature hot water shall not be used except in climate zones 6 and 7. Central plants providing heat source/heat sink for water source heat pumps are acceptable system types.

The CCP shall be ventilated in accordance with ASHRAE 55 and ASHRAE 15. Space heat shall be provided for freeze protection. No space within the CCP shall be air conditioned.

Multiple units for major equipment components such as chillers, boilers, pumps, and cooling towers shall be provided so that no more than 50% capacity is lost in the event of a single failure. However, backup or spare capacity is not authorized. System design shall be in accordance with ASHRAE Handbooks.

Equipment located outside shall be enclosed in a screened equipment yard. Sound/noise shall be a consideration in the selection of equipment. All hydronic systems shall have provisions for chemical treatment. Open loop systems shall incorporate continuous, automatic water treatment.

3.7.3. Fire Protection

Fire suppression systems shall be designed in accordance with the latest edition of UFC 3-600-01. However, the B/COF shall be classified as mission essential and shall be provided with sprinkler protection regardless of other criteria or code provisions. The facility shall be protected throughout by a complete automatic sprinkler system. Fire alarm systems shall be addressable type with addressable devices. The type, function and location of the fire alarm annunciator shall be coordinated with the local authority having jurisdiction.

3.8. ELECTRICAL AND TELECOMMUNICATIONS REQUIREMENTS

Select electrical characteristics of the power system to provide a safe, efficient, and economical distribution of power based upon the size and types of loads to be served. Use distribution and utilization voltages of the highest level that is practical for the load to be served. The effect of nonlinear loads such as computers, other electronic

equipment and electronic ballasts shall be considered and accommodated as necessary. Transient voltage surge protection shall be provided for B/COFs, BNHQs and BDEHQs.

3.8.1. Power outlets

Power shall be provided for all installed equipment requiring power including all government furnished contractor installed equipment and all GFGI equipment. Power poles are not allowed. The following shall also be provided.

3.8.1.1. Provide 125-volt duplex receptacles per NFPA 70 in conjunction with the proposed equipment and furniture layouts, and as per other stated requirements elsewhere in the RFP.

3.8.1.2. In addition to receptacles required elsewhere in the RFP provide one 125-volt duplex receptacle per wall in all normally occupied spaces.

3.8.1.3. For housekeeping purposes provide a minimum of one 125-volt, duplex receptacle per corridor and a minimum of one 125-volt duplex receptacle on each wall within the lobby. No point along bottom of corridor or lobby walls shall be more than 25 feet from a receptacle.

3.8.1.4. Provide 125-volt duplex receptacles mounted adjacent to lavatories. Provide a minimum of one for every two adjacent lavatories. Each single lavatory shall also be provided a receptacle.

3.8.1.5. Provide a minimum of two 125-volt, duplex receptacles in each mechanical room in addition to NFPA 70 requirements. In addition, provide a minimum of one 125-volt duplex receptacle in each electrical room.

3.8.1.6. Provide a 125-volt quadraplex receptacle on a dedicated circuit for the CQ station.

3.8.2. Grounding

Grounding shall be provided in accordance with NFPA 70 and the Technical Criteria for I3A. In addition raised flooring shall be grounded to the building's primary grounding electrode.

3.8.3. Lighting

Interior lighting controls shall be provided in accordance with ASHRAE 90.1. Local manual controls shall supplement automatic controls in offices, large open work spaces, and specialized areas such as, computer learning centers, multipurpose spaces and covered assembly areas. Compact fluorescent lamps of 12 watts or less shall not be used. Electronic ballasts for linear fluorescent lamps shall be the high efficiency programmed start type. Provided lighting levels shall be within +/- 10% of required lighting levels.

3.8.3.1. An un-switched fixture with emergency ballast shall be provided at the entrance to each arms vault. Fixture shall be vandal resistant.

3.8.3.2. Covered assembly areas shall be illuminated to a level of 15 foot-candles.

3.8.3.3. Lobbies in B/COF shall be illuminated to a level of 10 foot-candles. CQ station within the first floor lobby shall be illuminated to a level of 30 foot-candles.

3.8.3.4. Mechanical rooms, arms vault, computer learning center, multipurpose space, company supply, day room, weapons cleaning, and electrical rooms shall be illuminated to a level of 30 foot-candles.

3.8.3.5. Not Used

3.8.3.6. Not Used

3.8.4. Telecommunications System

Telecommunication outlets shall be provided per the applicable criteria based on functional purpose of the space within the building and in accordance with other provisions of this RFP.

3.8.4.1. Provide voice and data connection capability to all workstations.

3.8.4.2. The required connection capability in computer learning centers is a minimum of one voice outlet per room and one data outlet per occupant.

3.8.4.3. Provide each bedroom with two (one per desk) 8-pin modular jacks in separate outlets.

3.8.4.4. Provide a dual (voice and data) 8-pin modular jack outlet at the front of each partitioned area in each and multipurpose space.

3.8.5. Video Teleconferencing

3.8.5.1. Provide a dual (fiber optic and 8-pin modular) jack outlet for video teleconferencing connectivity in each: multipurpose space

3.8.5.2. Not Used

3.8.5.3. Not Used

3.8.6. Intrusion Detection System (IDS)

3.8.6.1. Infrastructure for an IDS shall be provided for each arms vault. Infrastructure shall consist of conduit, pull wire and outlet boxes. Outlet boxes are required for a control panel, balanced magnetic switch, motion sensor, and duress switch unless specified otherwise in paragraph 6.10. System requirements shall be coordinated with the Installation.

3.8.6.2. Not Used

3.8.7. CATV

All CATV outlet boxes, connectors, cabling, and cabinets shall conform to the Technical Criteria for I3A unless noted otherwise. All horizontal cabling shall be homerun from the CATV outlet to the nearest telecommunications room. See paragraph 6.0 PROJECT SPECIFIC REQUIREMENTS for possible additional requirements.

3.8.7.1. CATV connectivity shall be provided in: all multipurpose spaces, day rooms, and private offices.

3.8.7.2. Not Used

3.8.8. Not Used

3.8.9. Not Used

3.8.10. Not Used

3.8.11. Not Used

3.9. FIRE ALARM REQUIREMENTS

3.9.1. All software, software locks, special tools and any other proprietary equipment required to maintain, add devices to or delete devices from the system, or test the Fire Alarm system shall become property of the Government and be furnished to the Contracting Officer's Representative prior to final inspection of the system.

3.9.2. The fire alarm system installation shall be supervised by a National Institute for Certification of Engineering Technologies (NICET) 3 (minimum) technician.

3.9.3. Smoke detectors shall be provided in all bedrooms. Smoke detectors in bedrooms shall be monitored. Tampering with a smoke detector shall send a trouble signal. Trouble signals shall be transmitted to the fire department.

4.0 APPLICABLE CRITERIA

Unless a specific document version or date is indicated, use criteria from the most current references as of the date of issue of the contract or task order, including any applicable addenda, unless otherwise stated in the task order. In the event of conflict between References and/or Applicable Military Criteria, apply the most stringent requirement, unless otherwise specifically noted in the contract or task order.

4.1. INDUSTRY CRITERIA

Applicable design and construction criteria references are listed in Table 1 below. This list is not intended to include all criteria that may apply or to restrict design and construction to only those references listed. See also Paragraph 3 for additional facility-specific applicable criteria.

Table 1: Industry Criteria

Air Conditioning and Refrigeration Institute (ARI)	
ARI 310/380	Packaged Terminal Air-Conditioners and Heat Pumps
ARI 440	Room Fan-Coil and Unit Ventilator
ANSI/ARI 430-99	Central Station Air Handling Units
ARI 445	Room Air-Induction Units
ARI 880	Air Terminals
Air Movement and Control Association (AMCA)	
AMCA 210	Laboratory Methods of Testing Fans for Rating
American Architectural Manufacturers Association (AAMA)	
AAMA 605	Voluntary Specification Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels
AAMA 607.1	Voluntary Guide Specifications and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum
AAMA 1503	Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections
American Association of State Highway and Transportation Officials (AASHTO)	
	Roadside Design Guide [guardrails, roadside safety devices]
	Standard Specifications for Transportation Materials and Methods of Sampling and Testing [Road Construction Materials]

	Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals
	Guide for Design of Pavement Structures, Volumes 1 and 2 [pavement design guide]
	A Policy of Geometric Design of Highways and Streets
American Bearing Manufacturers Association (AFBMA)	
AFBMA Std. 9	Load Ratings and Fatigue Life for Ball Bearings
AFBMA Std. 11	Load Ratings and Fatigue Life for Roller Bearings
American Boiler Manufacturers Association (ABMA)	
ABMA ISEI	Industry Standards and Engineering Information
American Concrete Institute	
ACI 302.2R	Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials
ACI 318	Building Code Requirements for Structural Concrete
ACI SP-66	ACI Detailing Manual
ACI 530	Building Code Requirements for Masonry Structures
ADA Standards for Accessible Design	
See US Access Board	ADA and ABA Accessibility Guidelines for Buildings and Facilities, Chapters 3-10.
American Institute of Steel Construction (AISC)	
	Manual of Steel Construction – 13 th Edition (or latest version)
American Iron and Steel Institute	
AISI S100	North American Specification for the Design of Cold-Formed Steel Structural Members
American National Standards Institute 11 (ANSI)	

ANSI Z21.10.1	Gas Water Heaters Vol. 1, Storage water Heaters with Input Ratings of 75,000 Btu per Hour or less
ANSI Z124.3	American National Standard for Plastic Lavatories
ANSI Z124.6	Plastic Sinks
ANSI Z21.45	Flexible Connectors of Other Than All-Metal Construction for Gas Appliances
ANSI/IEEE C2-2007	National Electrical Safety Code
ANSI/AF&PA NDS-2001	National Design Specification for Wood Construction
American Society of Civil Engineers (ASCE)	
ASCE 7	Minimum Design Loads for Buildings and Other Structures
ASCE 37	Design and Construction of Sanitary and Storm Sewers, Manuals and Reports on Engineering Practice [sanitary sewer and storm drain design criteria]
ASCE/SEI 31-03	Seismic Evaluation of Existing Buildings [Existing Building Alteration/Renovation]
ASCE/SEI 41-06	Seismic Rehabilitation of Existing Buildings [Existing Building Alteration/Renovation]
American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)	
ASHRAE 90.1	ANSI/ASHRAE/IESNA 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE Guideline 0	The Commissioning Process
ASHRAE Guideline 1.1	The HVAC Commissioning Process
ASHRAE Handbooks	Fundamentals, HVAC Applications, Systems and Equipment, Refrigeration (Applicable, except as otherwise specified)
ASHRAE Standard 15	Safety Standard for Refrigeration Systems
ASHRAE Standard 62.1	Ventilation for Acceptable Indoor Air Quality
ASHRAE Standard 55	Thermal Environmental Conditions for Human Occupancy

American Society of Mechanical Engineers International (ASME)	
ASME BPVC SEC VII	Boiler and Pressure Vessel Code: Section VII Recommended Guidelines for the Care of Power Boilers
ASME A17.1	Safety Code for Elevators and Escalators
ASME B 31 (Series)	Piping Codes
American Water Works Association (AWWA)	
	Standards [standards for water line materials and construction]
American Welding Society	
	Welding Handbook
	Welding Codes and Specifications (as applicable to application, see International Building Code for example)
Architectural Woodwork Institute (AWI)	
Version 1.2	AWI Quality Standards 7th Edition
Associated Air Balance Council (AABC)	
AABC MN-1	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems
	AABC Associated Air Balance Council Testing and Balance Procedures
ASTM International	
ASTM C1060-90(1997)	Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings
ASTM E 779 (2003)	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
ASTM E1827-96(2002)	Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
Builders Hardware Manufacturers Association (BHMA)	
ANSI/BHMA	American National Standards for Builders Hardware

Building Industry Consulting Service International	
	Telecommunications Distribution Methods Manual (TDMM)
	Customer-Owned Outside Plant Design Manual (CO-OSP)
Code of Federal Regulations (CFR)	
49 CFR 192	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards
10 CFR 430	Energy Conservation Program for Consumer Products
Consumer Electronics Association	
CEA 709.1B	Control Network Protocol Specification
CEA 709.3	Free-Topology Twisted-Pair Channel Specification
CEA 852	Tunneling Component Network Protocols Over Internet Protocol Channels
Electronic Industries Association (EIA)	
ANSI/EIA/TIA 568	Structured Cabling Series
ANSI/EIA/TIA 569	Commercial Building Standard for Telecommunications Pathways and Spaces (includes ADDENDA)
ANSI/TIA/EIA-606	Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings
J-STD EIA/TIA 607	Commercial Building Grounding and Bonding Requirements for Telecommunications
Federal Highway Administration (FHWA)	
	Manual on Uniform Traffic Control Devices for Streets and Highways [signage and pavement markings for streets and highways]
FHWA-NHI-01-021	Hydraulic Engineering Circular No. 22, Second Edition, URBAN DRAINAGE DESIGN MANUAL
Illuminating Engineering Society of North America (IESNA)	
IESNA RP-1	Office Lighting

IESNA RP-8	Roadway Lighting
IESNA Lighting Handbook	Reference and Application
Institute of Electrical and Electronics Engineers Inc. (IEEE)	
	Standard for Use of the International System of Units (SI): the Modern Metric System
Standard 1100	Recommended Practice for Powering and Grounding Sensitive Electronic Equipment
International Code Council (ICC)	
IBC	<p>International Building Code</p> <p>Note: All references in the International Building Code to the International Electrical Code shall be considered to be references to NFPA 70.</p> <p>All references in the International Building Code to the International Fuel Gas Code shall be considered to be references to NFPA 54 and NFPA 58.</p> <p>All references in the International Building Code to the International Fire Code and Chapter 9 shall be considered to be references to Unified Facilities Criteria (UFC) 3-600-01.</p>
IMC	<p>International Mechanical Code –</p> <p>Note: For all references to “HEATING AND COOLING LOAD CALCULATIONS”, follow ASHRAE 90.1</p> <p>Note: For all references to “VENTILATION”, follow ASHRAE 62.1</p>
IRC	International Residential Code
IPC	International Plumbing Code
IEC	Energy Conservation Code (IEC) –Applicable only to the extent specifically referenced herein. Refer to Paragraph 5, ENERGY CONSERVATION requirements.
IGC	International Gas Code - not applicable. Follow NFPA 54, National Fuel Gas Code and NFPA 58, Liquefied Petroleum Gas Code.
International Organization for Standardization (ISO)	
ISO 6781:1983	Qualitative detection of thermal irregularities in building envelopes –

	infrared method
LonMark International (LonMark)	
LonMark Interoperability Guidelines	(available at www.lonmark.org), including: Application Layer Guidelines, Layer 1-6 Guidelines, and External Interface File (XIF) Reference Guide
LonMark Resource Files	(available at www.lonmark.org), including Standard Network Variable Type (SNVT) definitions
Metal Building Manufacturers Association (MBMA)	
	Metal Building Systems Manual
Midwest Insulation Contractors Association (MICA)	
	National Commercial and Industrial Insulation Standards Manual
National Association of Corrosion Engineers International (NACE)	
NACE RP0169	Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE RP0185	Extruded, Polyolefin Resin Coating Systems with Adhesives for Underground or Submerged Pipe
NACE RP0285	Corrosion Control of Underground Storage Tank Systems by Cathodic Protection
NACE RP0286	Electrical Isolation of Cathodically Protected Pipelines
National Electrical Manufacturers Association (NEMA)	
National Environmental Balancing Bureau (NEBB)	
	Procedural Standards Procedural Standards for Testing Adjusting Balancing of Environmental Systems
National Fire Protection Association (NFPA)	
NFPA 10	Standard for Portable Fire Extinguishers
NFPA 13	Installation of Sprinkler Systems
NFPA 13R	Residential Occupancies up to and Including Four Stories in Height Sprinkler Systems

NFPA 14	Standard for the Installation of Standpipes and Hose Systems
NFPA 20	Installation of Centrifugal Fire Pumps
NFPA 24 NFPA 25	Standard for the Installation of Private Fire Service Mains and Their Appurtenances [underground fire protection system design] Inspection, Testing And Maintenance Of Water-Based Fire Protection Systems
NFPA 30	Flammable and Combustible Liquids Code
NFPA 30A	Motor Fuel Dispensing Facilities and Repair Garages
NFPA 31	Installation of Oil Burning Equipment
NFPA 54	National Fuel Gas Code
NFPA 58	Liquefied Petroleum Gas Code
NFPA 70	National Electrical Code
NFPA 72	National Fire Alarm Code
NFPA 76	Fire Protection of Telecommunications Facilities
NFPA 80	Standard for Fire Doors and Fire Windows
NFPA 90a	Installation of Air Conditioning and Ventilating Systems
NFPA 96	Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
NFPA 101	Life Safety Code
NFPA 780	Standard for the Installation of Lightning Protection Systems
National Roofing Contractor's Association (NRCA)	
	Roofing and Waterproofing Manual
National Sanitation Foundation, International	
NSF/ANSI Std. 2, 3, 4, 5, 6, 7, 8, 12, 13, 18, 20, 21, 25, 29, 35, 36, 37, 51, 52, 59,	Food Equipment Standards

169	
ANSI/UL Std. 73, 197, 471, 621, 763	Food Equipment Standards
CSA Std. C22.2 No. 109, 120, 195	Food Equipment Standards
Occupational Safety and Health Administration (OSHA)	
Title 29, Part 1926	OSHA Construction Industry Standards, Title 29, Code of Federal Regulations, Part 1926, Safety and Health Regulations for Construction
Plumbing and Drainage Institute (PDI)	
PDI G 101	Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data
PDI WH201	Water Hammer Arrestors
Precast Concrete Institute	
PCI Design Handbook	Precast and Prestressed Concrete
Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)	
SMACNA HVAC Duct Construction Standards	HVAC Duct Construction Standards - Metal and Flexible
SMACNA Architectural Manual	Architectural Sheet Metal Manual
SMACNA HVAC TAB	HVAC Systems - Testing, Adjusting and Balancing
State/Local Regulations	
	State Department of Transportation Standard Specifications for Highway and Bridge Construction
	Sedimentation and Erosion Control Design Requirements
	Environmental Control Requirements
	Storm Water Management Requirements
Steel Door Institute (SDI)	

ANSI A250.8/SDI 100	Standard Steel Doors and Frames
Steel Deck Institute	
	SDI Diaphragm Design Manual
Steel Joist Institute	
	Catalog of Standard Specifications and Load Tables for Steel Joists and Joist Girders
Underwriters Laboratories (UL)	
UL 96A	Installation Requirements for Lightning Protection Systems
UL 300	Standard for Safety for Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas
UNITED STATES ACCESS BOARD: U.S. ARCHITECTURAL AND TRANSPORTATION BARRIERS COMPLIANCE BOARD	
ADA and ABA Accessibility Guidelines for Buildings and Facilities	<p>ABA Accessibility Standard for DoD Facilities</p> <p>Derived from the ADA and ABA Accessibility Guidelines: Specifically includes: ABA Chapters 1 and 2 and Chapters 3 through 10.</p> <p>Use this reference in lieu of IBC Chapter 11.</p> <p>Excluded are:</p> <p>(a) Facilities, or portions of facilities, on a military installation that are designed and constructed for use exclusively by able-bodied military personnel (See Paragraph 3 for any reference to this exclusion).</p> <p>(b) Reserve and National Guard facilities, or portions of such facilities, owned by or under the control of the Department of Defense, that are designed and constructed for use exclusively by able-bodied military personnel. (See paragraph 3 for any reference to this exclusion).</p>
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES	
	FDA National Food Code
U.S. GREEN BUILDING COUNCIL (USGBC)	
LEED-NC	Green Building Rating System for New Construction & Major Renovations
	Application Guide for Multiple Buildings and On-Campus Building Projects

4.2. MILITARY CRITERIA

The project shall conform to the following criteria. Certain design impacts and features due to these criteria are noted for the benefit of the offeror. However, all requirements of the referenced criteria will be applicable, whether noted or not, unless otherwise specified herein.

4.2.1. Energy Policy Act of 2005 (Public Law 109-58) (applies only to the extent specifically implemented in the contract, which may or may not directly cite or reference EPACT)

4.2.2. Executive Order 12770: Metric Usage In Federal Government

(a) Metric design and construction is required except when it increases construction cost. Offeror to determine most cost efficient system of measurement to be used for the project.

4.2.3. TB MED 530: Occupational and Environmental Health Food Sanitation

4.2.4. Unified Facilities Criteria (UFC) 3-410-01FA: Heating, Ventilating, and Air Conditioning - applicable only to the extent specified in paragraph 5, herein.

4.2.5. Deleted.

4.2.6. UFC 3-600-01 Design: Fire Protection Engineering for Facilities. Use the latest edition of the IBC in coordination with this UFC. Use Chapters 3, 6, 7, 33 and UFC 3-600-01. If any conflict occurs between these Chapters and UFC 3-600-01, the requirements of UFC 3-600-01 take precedence. Use UFC 3-600-01 in lieu of IBC Chapters 4, 8,9,10.

4.2.7. UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings

4.2.8. UFC 4-023-03 Design of Buildings to Resist Progressive Collapse (Use most recent version, regardless of references thereto in other publications)

(a) Note the option to use tie force method or alternate path design for Occupancy Category II.

4.2.9. UFC 4-021-01 Design and O&M: Mass Notification Systems

4.2.10. Technical Criteria for Installation Information Infrastructure Architecture (I3A)

(a) Email: DetrickISECI3Aguide@conus.army.mil

4.2.11. U.S. Army Information Systems Engineering Command (USAISEC) TG for the Integration of SECRET Internet Protocol (IP) Router Network (SIPRNET). See Paragraph 3 for applicability to specific facility type. May not apply to every facility. This is mandatory criteria for those facilities with SIPRNET.

5.0 GENERAL TECHNICAL REQUIREMENTS

This paragraph contains general technical requirements. See also Paragraph 3 for facility-specific technical requirements. Residential or similar grade finishes and materials are not acceptable for inclusion in these buildings, unless otherwise specifically allowed.

5.1. SITE PLANNING AND DESIGN

5.1.1. STANDARDS AND CODES: The site planning and design shall conform to APPLICABLE CRITERIA and to paragraph 6, PROJECT SPECIFIC REQUIREMENTS.

5.1.2. SITE PLANNING OBJECTIVES: Group buildings in configurations that create a sense of community and promote pedestrian use. See paragraph 3 for additional site planning requirements relating to building functions.

5.1.2.1. Provide enclosures and or visual screening devices for Outdoor Utility such as dumpsters, emergency generators, transformers, heating, ventilation, and air conditioning units from streetscape and courtyard views to limit visual impact. Enclosures shall be compatible with the building they serve and accessible by vehicle. The location of dumpsters can have a significant visual impact and should be addressed as part of an overall building design and incorporated in site planning.

5.1.2.2. Where included in the project, dumpster pads shall be concrete (minimum of 8 inches thick on 4 inch base course, unless site conditions dictate more conservative requirements) and directly accessible by way of a paved service drive or parking lot with adequate overhead clearance for collection vehicles. Provide space at dumpster areas for recycling receptacles. Coordinate with Installation on recycling receptacle types, sizes and access requirements and provide space at dumpster areas to accommodate them.

5.1.2.3. Vehicular Circulation. Apply design vehicle templates provided by the American Association of State Highway and Transportation Officials (AASHTO) to the site design. The passenger car class includes passenger cars and light trucks, such as vans and pick-ups. The passenger car template is equivalent to the non-organizational – privately owned vehicle (POV). The truck class template includes single-unit trucks, recreation vehicles, buses, truck tractor-semi-trailer combinations, and trucks or truck tractors with semi-trailers in combination with full trailers. Provide vehicle clearances required to meet traffic safety for emergency vehicles, service vehicles, and moving vans. Provide required traffic control signage Site entrances and site drive aisles shall maximize spacing between drives, incorporate right-angle turns, and limit points of conflict between traffic. Design Services Drives to restrict access to unauthorized vehicles by removable bollards, gates, or other barriers to meet Anti-Terrorism/Force Protection (ATFP) requirements. Orient service drives to building entrances other than the primary pedestrian entry at the front of the building.

5.1.2.4. Provide Emergency Vehicle Access around the facility and shall be in accordance with AT/FP requirements. Maintain a 33-foot clear zone buffer for emergency vehicles, designed to prevent other vehicles from entering the AT/FP standoff to the building.

5.1.2.5. Clear and grub all trees and vegetation necessary for construction; but, save as many trees as possible. Protect trees to be saved during the construction process from equipment.

5.1.2.6. Stormwater Management. Employ design and construction strategies (Best Management Practices) that reduce stormwater runoff, reduce discharges of polluted water offsite and maintain or restore predevelopment hydrology with respect to temperature, rate, volume and duration of flow to the maximum extent practicable. See paragraph 6, PROJECT SPECIFIC requirements for additional information.

5.1.3. EXTERIOR SIGNAGE: Provide exterior signage in accordance with Appendix H, Exterior Signage. Provide exterior NO SMOKING signage that conveys building and grounds smoking policy.

5.1.4. EXISTING UTILITIES: Base utilities maps and capacities for this site are included as part of this RFP. See paragraph 6 for more detailed information.

5.2. SITE ENGINEERING

5.2.1. STANDARDS AND CODES: The site engineering shall conform to APPLICABLE CRITERIA.

5.2.2. SOILS:

5.2.2.1. A report has been prepared to characterize the subsurface conditions at the project site and is **appended to these specifications**. The report provides a general overview of the soil and geologic conditions with detailed descriptions at discrete boring locations. The Contractor's team shall include a licensed geotechnical engineer to interpret the report and develop earthwork and foundation recommendations and design parameters in which to base the contractor's design. If any additional subsurface investigation or laboratory analysis is required to better characterize the site or develop the final design, the Contractor shall perform it under the direction of a licensed geotechnical engineer. There will be no separate payment for the cost of additional tests. If differences between the Contractor's additional subsurface investigation and the government provided soils report or the reasonably expected conditions require material revisions in the design, an equitable adjustment may be made, in accordance with the provisions of the Differing Site Conditions clause. The basis for the adjustment would be the design and construction appropriate for the conditions described in the Government furnished report or the reasonably expected conditions, in comparison with any changes required by material differences in the actual conditions encountered, in accordance with the terms of contract clause Differing Site Conditions.

5.2.2.2. The contractor's licensed geotechnical engineer shall prepare a final geotechnical evaluation report, to be submitted along with the first foundation design submittal, as described in Section 01 33 16, *Design After Award*.

5.2.3. VEHICLE PAVEMENTS: (as applicable to the project)

5.2.3.1. Design procedures and materials shall conform to one of the following: 1) the USACE Pavement Transportation Computer Assisted Structural Engineering (PCASE) program, 2) American Association of State Highway and Transportation Officials (AASHTO) or, 3) the applicable state Department of Transportation standards in which the project is located. See paragraph 5.2.2.2 and Section 01 33 16 for required information for the Contractor's geotechnical evaluation report. The minimum flexible pavement section shall consist of 2 inches of asphalt and 6 inches of base or as required by the pavement design, whichever is greater, unless specifically identified by the Government to be a gravel road. Design roads and parking areas for a life expectancy of 25 years with normal maintenance. Parking area for tactical vehicles (as applicable to the project) shall be Portland Cement Concrete (PCC) rigid pavement design. For concrete pavements, submit joint layout plan for review and concurrence. Design pavements for military tracked vehicles (as applicable to the project) IAW USACE PCASE. Traffic estimates for each roadway area will be as shown on the drawings or listed in Section 01 10 00 Paragraph 6.4.4. Pavement markings and traffic signage shall comply with the Installation requirements and with the Manual on Uniform Traffic Control Devices.

5.2.3.2. Parking Requirements.

- (a) All handicap POV parking lots (where applicable in the facility specific requirements) shall meet the ADA and ABA Accessibility Guidelines for accessible parking spaces.
- (b) Design POV parking spaces for the type of vehicles anticipated, but shall be a minimum of 9 ft by 18 ft for POVs, except for two wheel vehicles.

5.2.3.3. Sidewalks. Design the network of walks throughout the complex (where applicable) to facilitate pedestrian traffic among facilities, and minimize the need to use vehicles. Incorporate sidewalks to enhance the appearance of the site development, while creating a sense of entry at the primary patron entrances to the buildings. Minimum sidewalk requirements are in Paragraph 3, where applicable.

5.2.4. CATHODIC PROTECTION: Provide cathodic protection systems for all underground metallic systems and metallic fittings/portions of non-metallic, underground systems, both inside and outside the building 5 foot line that are subject to corrosion. Coordinate final solutions with the installation to insure an approach that is consistent with installation cathodic protection programs.

5.2.5. UTILITIES: See paragraph 6.4.6 for specific information on ownership of utilities and utility requirements. Meter all utilities (gas, water, and electric, as applicable) to each facility. For Government owned utilities, install meters that are wireless data transmission capable as well as have a continuous manual reading option. All meters will be capable of at least hourly data logging and transmission and provide consumption data for gas, water, and electricity. Gas and electric meters will also provide demand readings based on consumption over a maximum of

any 15 minute period. Configure all meters to transmit at least daily even if no receiver for the data is currently available at the time of project acceptance. For privatized utilities, coordinate with the privatization utility(ies) for the proper meter base and meter installation.

5.2.6. PERMITS: The CONTRACTOR shall be responsible for obtaining all permits (local, state and federal) required for design and construction of all site features and utilities.

5.2.7. IRRIGATION. Landscape irrigation systems, if provided, shall comply with the following:

5.2.7.1. Irrigation Potable Water Use Reduction. Reduce irrigation potable water use by 100 percent using LEED credit WE1.1 baseline (no potable water used for irrigation), except where precluded by other project requirements.

5.2.8. EPA WaterSense Products and Contractors. Except where precluded by other project requirements, use EPA WaterSense labeled products and irrigation contractors that are certified through a WaterSense labeled program where available.

5.3. ARCHITECTURE AND INTERIOR DESIGN:

This element will be evaluated per APPLICABLE CRITERIA under the quality focus.

5.3.1. STANDARDS AND CODES: The architecture and interior design shall conform to APPLICABLE CRITERIA.

5.3.2. GENERAL: Overall architectural goal is to provide a functional, quality, visually appealing facility that is a source of pride for the installation and delivered within the available budget and schedule.

5.3.3. COMPUTATION OF AREAS: See APPENDIX Q for how to compute gross and net areas of the facility(ies).

5.3.4. BUILDING EXTERIOR: Design buildings to enhance or compliment the visual environment of the Installation. Where appropriate, reflect a human scale to the facility. Building entrance should be architecturally defined and easily seen. When practical, exterior materials, roof forms, and detailing shall be compatible with the surrounding development and adjacent buildings on the Installation and follow locally established architectural themes. Use durable materials that are easy to maintain. Exterior colors shall conform to the Installation requirements. See paragraph 6.

5.3.4.1. Building Numbers: Each building shall have exterior signage permanently attached on two faces of the building indicating the assigned building number or address. Building number signage details and locations shall conform to Appendix H, Exterior Signage.

5.3.5. BUILDING INTERIOR

5.3.5.1. Space Configuration: Arrange spaces in an efficient and functional manner in accordance with area adjacency matrices.

5.3.5.2. Surfaces: Appearance retention is the top priority for building and furniture related finishes. Provide low maintenance, easily cleaned room finishes that are commercially standard for the facility occupancy specified, unless noted otherwise.

5.3.5.3. Color: The color, texture and pattern selections for the finishes of the building shall provide an aesthetically pleasing, comfortable, easily maintainable and functional environment for the occupants. Coordination of the building colors and finishes is necessary for a cohesive design. Color selections shall be appropriate for the building type. The use of color, texture and pattern shall be used to path or way find through the building. Trendy colors that will become dated shall be limited to non-permanent finishes such as carpet and paint. Finishes should be selected with regards to aesthetics, maintenance, durability, life safety and image. Limit the number of similar colors for each material. Color of Ceramic and porcelain tile grout shall be medium range color to help hide soiling. Plastic laminate and solid surface materials shall have patterns that are mottled, flecked or speckled. Finish colors of fire extinguisher cabinets, receptacle bodies and plates, fire alarms / warning lights, emergency lighting, and other miscellaneous items shall be coordinated with the building interior. Color of equipment items on ceilings (speakers, smoke detectors, grills, etc.) shall match the ceiling color.

5.3.5.4. Circulation: Circulation schemes must support easy way finding within the building.

5.3.5.5. Signage: Provide interior signage for overall way finding and life safety requirements. A comprehensive interior plan shall be from one manufacturer. Include the following sign types: (1) Lobby Directory, (2) Directional Signs; (3) Room Identification Signs; (4) Building Service Signs; (5) Regulatory Signs; (6) Official and Unofficial Signs (7) Visual Communication Boards (8) NO SMOKING signage that conveys building smoking policy. Use of emblems or logos may also be incorporated into the signage plan.

5.3.5.6. Window Treatment: Interior window treatments with adjustable control shall be provided in all exterior window locations for control of day light coming in windows or privacy at night. Uniformity of treatment color and material shall be maintained to the maximum extent possible within a building.

5.3.6. COMPREHENSIVE INTERIOR DESIGN

5.3.6.1. Comprehensive Interior Design includes the integration of a Structural Interior Design (SID) and a Furniture, Fixtures and Equipment (FF&E) design and package. SID requires the design, selection and coordination of interior finish materials that are integral to or attached to the building structure. Completion of a SID involves the selection and specification of applied finishes for the building's interior features including, but not limited to, walls, floors, ceilings, trims, doors, windows, window treatments, built-in furnishings and installed equipment, lighting, and signage. The SID package includes finish schedules, finish samples and any supporting interior elevations, details or plans necessary to communicate the building finish design and build out. The SID also provides basic space planning for the anticipated FF&E requirements in conjunction with the functional layout of the building and design issues such as life safety, privacy, acoustics, lighting, ventilation, and accessibility. See Section 01 33 16 for SID design procedures.

The FF&E design and package includes the design, selection, color coordination and of the required furnishing items necessary to meet the functional, operational, sustainability, and aesthetic needs of the facility coordinated with the interior finish materials in the SID. The FF&E package includes the specification, procurement documentation, placement plans, ordering and finish information on all freestanding furnishings and accessories, and a cost estimate. Coordinate the selection of furniture style, function and configuration with the defined requirements. Examples of FF&E items include, but are not limited to workstations, seating, files, tables, beds, wardrobes, draperies and accessories as well as marker boards, tack boards, and presentation screens. Criteria for furniture selection include function and ergonomics, maintenance, durability, sustainability, comfort and cost. See Section 01 33 16 for FFE design procedures.

5.4. STRUCTURAL DESIGN

5.4.1. STANDARDS AND CODES: The structural design shall conform to APPLICABLE CRITERIA.

5.4.2. GENERAL: The structural system needs to be compatible with the intended functions and components that allows for future flexibility and reconfigurations of the interior space. Select an economical structural system based upon facility size, projected load requirements and local availability of materials and labor. Base the structural design on accurate, site specific geotechnical information and anticipated loads for the building types and geographical location. When modular units or other pre-fabricated construction is used or combined with stick-built construction, fully coordinate and integrate the overall structural design between the two different or interfacing construction types. If the state that the project is located in requires separate, specific licensing for structural engineers (for instance, such as in Florida, California and others), then the structural engineer designer of record must be registered in that state.

5.4.3. LOADS: See paragraph 3 for facility specific (if applicable) and paragraph 6 for site and project specific structural loading criteria. Unless otherwise specified in paragraph 6, use Exposure Category C for wind. If not specified, use Category C unless the Designer of Record can satisfactorily justify another Exposure Category in its design analysis based on the facility Master Plan. Submit such exceptions for approval as early as possible and prior to the Interim Design Submittal in Section "Design After Award"

5.4.4. TERMITE TREATMENT: (Except Alaska) Provide termite prevention treatment in accordance with Installation and local building code requirements, using licensed chemicals and licensed applicator firm.

5.5. THERMAL PERFORMANCE

5.5.1. STANDARDS AND CODES: Building construction and thermal insulation for mechanical systems shall conform to APPLICABLE CRITERIA.

5.5.2. BUILDING ENVELOPE SEALING PERFORMANCE REQUIREMENT. Design and construct the building envelope for office buildings, office portions of mixed office and open space (e.g., company operations facilities), dining, barracks and instructional/training facilities with a continuous air barrier to control air leakage into, or out of, the conditioned space. Clearly identify all air barrier components of each envelope assembly on construction documents and detail the joints, interconnections and penetrations of the air barrier components. Clearly identify the boundary limits of the building air barriers, and of the zone or zones to be tested for building air tightness on the drawings.

5.5.2.1. Trace a continuous plane of air-tightness throughout the building envelope and make flexible and seal all moving joints.

5.5.2.2. The air barrier material(s) must have an air permeance not to exceed 0.004 cfm / sf at 0.3" wg (0.02 L/s.m2 @ 75 Pa) when tested in accordance with ASTM E 2178

5.5.2.3. Join and seal the air barrier material of each assembly in a flexible manner to the air barrier material of adjacent assemblies, allowing for the relative movement of these assemblies and components.

5.5.2.4. Support the air barrier so as to withstand the maximum positive and negative air pressure to be placed on the building without displacement, or damage, and transfer the load to the structure.

5.5.2.5. Seal all penetrations of the air barrier. If any unavoidable penetrations of the air barrier by electrical boxes, plumbing fixture boxes, and other assemblies are not airtight, make them airtight by sealing the assembly and the interface between the assembly and the air barrier or by extending the air barrier over the assembly.

5.5.2.6. The air barrier must be durable to last the anticipated service life of the assembly.

5.5.2.7. Do not install lighting fixtures with ventilation holes through the air barrier

5.5.2.8. Provide a motorized damper in the closed position and connected to the fire alarm system to open on call and fail in the open position for any fixed open louvers such as at elevator shafts.

5.5.2.9. Damper and control to close all ventilation or make-up air intakes and exhausts, atrium smoke exhausts and intakes, etc when leakage can occur during inactive periods.

5.5.2.10. Compartmentalize garages under buildings by providing air-tight vestibules at building access points.

5.5.2.11. Compartmentalize spaces under negative pressure such as boiler rooms and provide make-up air for combustion.

5.5.2.12. Performance Criteria and Substantiation: Submit the qualifications and experience of the testing entity for approval. Demonstrate performance of the continuous air barrier for the opaque building envelope by the following tests:

(a) Test the completed building and demonstrate that the air leakage rate of the building envelope does not exceed 0.25cfm/ft2 at a pressure differential of 0.3" w.g.(75 Pa) in accordance with ASTM's E 779 (2003) or E-1827-96 (2002). Accomplish tests using either pressurization or depressurization or both. Divide the volume of air leakage in cfm @ 0.3" w.g. (L/s @ 75 Pa) by the area of the pressure boundary of the building, including roof or ceiling, walls and floor to produce the air leakage rate in cfm/ft2 @ 0.3" w.g. (L/s.m2 @ 75 Pa). Do not test the building until verifying that the continuous air barrier is in place and installed without failures in accordance with installation instructions so that repairs to the continuous air barrier, if needed to comply with the required air leakage rate, can be done in a timely manner.

(b) Test the completed building using Infrared Thermography testing. Use infrared cameras with a resolution of 0.1deg C or better. Perform testing on the building envelope in accordance with ISO 6781:1983 and ASTM C1060-90(1997). Determine air leakage pathways using ASTM E 1186-03 Standard Practices for Air Leakage Site

Detection in Building Envelopes and Air Barrier Systems, and perform corrective work as necessary to achieve the whole building air leakage rate specified in (a) above.

(c) Notify the Government at least three working days prior to the tests to provide the Government the opportunity to witness the tests. Provide the Government written test results confirming the results of all tests.

5.6. PLUMBING

5.6.1. STANDARDS AND CODES: The plumbing system shall conform to APPLICABLE CRITERIA.

5.6.2. PRECAUTIONS FOR EXPANSIVE SOILS: Where expansive soils are present, the design for underslab piping systems and underground piping serving chillers, cooling towers, etc, shall include features to control forces resulting from soil heave. Some possible solutions include, but are not necessarily limited to, features such as flexible expansion joints, slip joints, horizontal offsets with ball joints, or multiple bell and spigot gasketed fittings. For structurally supported slabs, piping should be suspended from the structure with adequate space provided below the pipe for the anticipated soil movement.

5.6.3. HOT WATER SYSTEMS: For Hot Water heating and supply, provide a minimum temp of 140 Deg F in the storage tank and a maximum of 110 Deg F at the fixture, unless specific appliances or equipment specifically require higher temperature water supply.

5.6.4. SIZING HOT WATER SYSTEMS: Unless otherwise specified or directed in paragraph 3, design in accordance with ASHRAE Handbook Series (appropriate Chapters), ASHRAE Standard 90.1, and the energy conservation requirements of the contract. Size and place equipment so that it is easily accessible and removable for repair or replacement.

5.6.5. JANITOR CLOSETS: In janitor spaces/room/closets, provide at minimum, a service sink with heavy duty shelf and wall hung mop and broom rack(s).

5.6.6. FLOOR DRAINS: As a minimum, provide floor drains in mechanical rooms and areas, janitor spaces/rooms/closets and any other area that requires drainage from fixtures or equipment, drain downs, condensate, as necessary.

5.6.7. URINALS: Urinals shall be vitreous china, wall-mounted, wall outlet, non-water using, with integral drain line connection, and with sealed replaceable cartridge or integral liquid seal trap. Either type shall use a biodegradable liquid to provide the seal and maintain a sanitary and odor-free environment. Install, test and maintain in accordance with manufacturer's recommendations. Slope the sanitary sewer branch line for non-water use urinals a minimum of 1/4 inch per foot. Do not use copper tube or pipe for drain lines that connect to the urinal. Manufacturer shall provide an operating manual and on-site training to installation operations personnel for the proper care and maintenance of the urinal. For complexes, non-water using urinals are not required for barracks type spaces.

5.6.8. BUILDING WATER USE REDUCTION. Reduce building potable water use in each building 30 percent using IPC fixture performance requirements baseline.

5.6.9. Do not use engineered vent or Sovent® type drainage systems.

5.6.10. Where the seasonal design temperature of the cold water entering a building is below the seasonal design dew point of the indoor ambient air, and where condensate drip will cause damage or create a hazard, insulate plumbing piping with a vapor barrier type of insulation to prevent condensation. Do not locate water or drainage piping over electrical wiring or equipment unless adequate protection against water (including condensation) damage is provided. Insulation alone is not adequate protection against condensation. Follow ASHRAE Fundamentals Chapter 23, Insulation for Mechanical Systems, IMC paragraph 1107 and International Energy Conservation Code for pipe insulation requirements.

5.7. ELECTRICAL AND TELECOMMUNICATIONS SYSTEMS

5.7.1. STANDARDS AND CODES: The electrical systems for all facilities shall conform to APPLICABLE CRITERIA.

5.7.2. MATERIALS AND EQUIPMENT: Materials, equipment and devices shall, as a minimum, meet the requirements of Underwriters Laboratories (UL) where UL standards are established for those items. Wiring for branch circuits shall be copper. Motors larger than one-half horsepower shall be three phase. All electrical systems shall be pre-wired and fully operational unless otherwise indicated. Wall mounted electrical devices (power receptacles, communication outlets and CATV outlets) shall have matching colors, mounting heights and faceplates.

5.7.3. POWER SERVICE: Primary service from the base electrical distribution system to the pad-mounted transformer and secondary service from the transformer to the building service electrical equipment room shall be underground. See paragraph 6 for additional site electrical requirements.

5.7.3.1. Spare Capacity: Provide 10% space for future circuit breakers in all panelboards serving residential areas of buildings and 15% spaces in all other panelboards.

5.7.4. TELECOMMUNICATION SERVICE: The project's facilities must connect to the Installation telecommunications (voice and data) system through the outside plant (OSP) telecommunications underground infrastructure cabling system per the I3A Criteria. Connect to the OSP cabling system from each facility main cross connect located in the telecommunications room.

5.7.5. LIGHTING: Comply with the recommendations of the Illumination Engineering Society of North America (IESNA), the National Energy Policy Act and Energy Star requirements for lighting products..

5.7.5.1. Interior Lighting:

(a) Reflective Surfaces: Coordinate interior architectural space surfaces and colors with the lighting systems to provide the most energy-efficient workable combinations.

(b) High Efficiency Fluorescent Lighting: Utilize NEMA premium electronic ballasts and energy efficient fluorescent lamps with a Correlated Color Temperature (CCT) of 4100K. Linear fluorescent and compact fluorescent fixtures shall have a Color Rendering Index of (CRI) of 87 or higher. Fluorescent lamps shall be the low mercury type qualifying as non-hazardous waste upon disposal. Do not use surface mounted fixtures on acoustical tile ceilings. Provide an un-switched fixture with emergency ballast shall be provided at each entrance to the building.

(c) Solid State Lighting: Fixtures shall provide lighting with a minimum Correlated Color Temperature (CCT) of 4100K and shall have a Color Rendering Index of (CRI) of 75 or higher. Verify performance of the light producing solid state components by a test report in compliance with the requirements of IESNA LM 80. Verify performance of the solid state light fixtures by a test report in compliance with the requirements of IESNA LM 79. Provide lab results by a NVLAP certified laboratory. The light producing solid state components and drivers shall have a life expectancy of 50,000 operating hours while maintaining at least 70% of original illumination level. Provide a complete five year warranty for fixtures.

(d) Metal Halide Lighting (where applicable): Metal Halide lamp fixtures in the range of 150-500 Watts shall be pulse start type and have a minimum efficiency rating of 88%.

(e) Lighting Controls: ANSI/ASHRAE/IESNA 90.1 has specific lighting controls requirements. Provide a high level of lighting system control by individual occupants or by specific groups in multi-occupant spaces (classrooms, conference rooms) to promote the productivity, comfort and well being of the building occupants. In office spaces, the preferred lighting should be a 30 FC ambient lighting level with occupancy sensor controlled task lighting in the work spaces to provide a composite lighting level of 50 FC on the working surfaces. Consider incorporating daylighting techniques for the benefit of reducing lighting energy requirements while improving the quality of the indoor spaces. If daylight strategies are used, additional coordination is required with the architect and mechanical engineer. Additionally, incorporate electric lighting controls to take advantage of the potential energy savings.

(f) Exterior Lighting: See paragraph 6.9 for site specific information, if any, on exterior lighting systems. Minimize light pollution and light trespass by not over lighting and use cutoff type exterior luminaries.

5.7.6. TELECOMMUNICATION SYSTEM: All building telecommunications cabling systems (BCS) and OSP telecommunications cabling system shall conform to APPLICABLE CRITERIA to include I3A Technical Criteria. An acceptable BCS encompasses, but is not limited to, copper and fiber optic (FO) entrance cable, termination equipment, copper and fiber backbone cable, copper and fiber horizontal distribution cable, workstation outlets, racks, cable management, patch panels, cable tray, cable ladder, conduits, grounding, and labeling.. Items included

under OSP infrastructure encompass, but are not limited to, manhole and duct infrastructure, copper cable, fiber optic cable, cross connects, terminations, cable vaults, and copper and FO entrance cable.

5.7.6.1. Design, install, label and test all telecommunications systems in accordance with the I3A Criteria and ANSI/TIA/EIA 568, 569, and 606 standards. A Building Industry Consulting Services International (BICSI) Registered Communications Distribution Designer (RCDD) with at least 2 yrs related experience shall develop and stamp telecommunications design, and prepare the test plan. See paragraph 5.8.2.5 for design of environmental systems for Telecommunications Rooms.

5.7.6.2. The installers assigned to the installation of the telecommunications system or any of its components shall be regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. Key personnel; i.e., supervisors and lead installers assigned to the installation of this system or any of its components shall be BICSI Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel. In lieu of BICSI certification, supervisors and installers shall have a minimum of 5 years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products.

5.7.6.3. Perform a comprehensive end to end test of all circuits to include all copper and fiber optic cables upon completion of the BCS and prior to acceptance of the facility. The BCS circuits include but are not limited to all copper and fiber optic(FO) entrance cables, termination equipment, copper and fiber backbone cable, copper and fiber horizontal distribution cable, and workstation outlets. Test in accordance with ANSI/EIA/TIA 568 standards. Use test instrumentation that meets or exceeds the standard. Submit the official test report to include test procedures, parameters tested, values, discrepancies and corrective actions in electronic format. Test and accomplish all necessary corrective actions to ensure that the government receives a fully operational, standards based, code compliant telecommunications system.

5.7.7. LIGHTNING PROTECTION SYSTEM: Provide a lightning protection system where recommended by the Lightning Risk Assessment of NFPA 780, Annex L.

5.8. HEATING, VENTILATING, AND AIR CONDITIONING

5.8.1. STANDARDS AND CODES: The HVAC system shall conform to APPLICABLE CRITERIA.

5.8.2. DESIGN CONDITIONS.

5.8.2.1. Outdoor and indoor design conditions shall be in accordance with UFC 3-410-01FA. Outdoor air and exhaust ventilation requirements for indoor air quality shall be in accordance with ASHRAE 62.1. All Buildings with minimum LEED Silver requirement (or better) will earn LEED Credit EQ 7.1, Thermal Comfort-Design.

5.8.2.2. Design systems in geographical areas that meet the definition for high humidity in UFC 3-410-01FA in accordance with the special criteria for humid areas therein.

5.8.2.3. Cooling equipment may be oversized by up to 15 percent to account for recovery from night setback. Heating equipment may be oversized by up to 30 percent to account for recovery from night setback. Design single zone systems and multi-zone systems to maintain an indoor design condition of 50% relative humidity for cooling only. For heating only where the indoor relative humidity is expected to fall below 20% for extended periods, add humidification to increase the indoor relative humidity to 30%. Provide ventilation air from a separate dedicated air handling unit (DOAU) for facilities using multiple single zone fan-coil type HVAC systems. Do not condition outside air through fan coil units. Avoid the use of direct expansion cooling coils in air handling units with constant running fans that handle outside air.

5.8.2.4. Locate all equipment so that service, adjustment and replacement of controls or internal components are readily accessible for easy maintenance.

5.8.2.5. Environmental Requirements for Telecommunications Rooms,(including SIPRNET ROOMS, where applicable for specific facility type). Comply with ANSI/EIA/TIA 569 and the I3A.

5.8.2.6. Fire dampers: dynamic type with a dynamic rating suitable for the maximum air velocity and pressure differential to which the damper is subjected. Test each fire damper with the air handling and distribution system running.

5.8.3. BUILDING AUTOMATION SYSTEM. Provide a Building Automation System consisting of a building control network , and integrate the building control network into the UMCS as specified.

The building control network shall be a single complete non-proprietary Direct Digital Control (DDC) system for control of the heating, ventilating and air conditioning (HVAC) systems as specified herein. The building control network shall be an Open implementation of LONWORKS® technology using ANSI/EIA 709.1B as the only communications protocol and use only LonMark Standard Network Variable Types (SNVTs), as defined in the LonMark® Resource Files, for communication between DDC Hardware devices to allow multi-vendor interoperability.

5.8.3.1. The building automation system shall be open in that it is designed and installed such that the Government or its agents are able to perform repair, replacement, upgrades, and expansions of the system without further dependence on the original Contractor. This includes, but is not limited to the following:

- (a) Install hardware such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.
- (b) Necessary documentation (including rights to documentation and data), configuration information, configuration tools, programs, drivers, and other software shall be licensed to and otherwise remain with the Government such that the Government or its agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor.

5.8.3.2. All DDC Hardware shall:

- (a) Be connected to a TP/FT-10 ANSI/EIA 709.3 control network.
- (b) Communicate over the control network via ANSI/EIA 709.1B exclusively.
- (c) Communicate with other DDC hardware using only SNVTs
- (d) Conform to the LonMark® Interoperability Guidelines.
- (e) Be locally powered; link power (over the control network) is not acceptable.
- (f) Be fully configurable via standard or user-defined configuration parameter types (SCPT or UCPT), standard network variable type (SNVT) network configuration inputs (*nci*), or hardware settings on the controller itself to support the application. All settings and parameters used by the application shall be configurable via standard or user-defined configuration parameter types (SCPT or UCPT), standard network variable type (SNVT) network configuration inputs (*nci*), or hardware settings on the controller itself
- (g) Provide input and output SNVTs required to support monitoring and control (including but not limited to scheduling, alarming, trending and overrides) of the application. Required SNVTs include but are not limited to: SNVT outputs for all hardware I/O, SNVT outputs for all setpoints and SNVT inputs for override of setpoints.
- (h) To the greatest extent practical, not rely on the control network to perform the application..

5.8.3.3. Controllers shall be Application Specific Controllers whenever an ASC suitable for the application exists. When an ASC suitable for the application does not exist use programmable controllers or multiple application specific controllers.

5.8.3.4. Application Specific Controllers shall be LonMark Certified whenever a LonMark Certified ASC suitable for the application exists. For example, VAV controllers must be LonMark certified.

5.8.3.5. Application Specific Controllers (ASCs) shall be configurable via an LNS plug-in whenever t an ASC with an LNS plug-in suitable for the application exists.

5.8.3.6. Each scheduled system shall accept a network variable of type SNVT_occupancy and shall use this network variable to determine the occupancy mode. If the system has not received a value to this network variable for more than 60 minutes it shall default to a configured occupancy schedule.

5.8.3.7. Gateways may be used provided that each gateway communicates with and performs protocol translation for control hardware controlling one and only one package unit.

5.8.3.8. Not Used

5.8.3.9. Perform all necessary actions needed to fully integrate the building control system. These actions include but are not limited to:

- Configure M&C Software functionality including: graphical pages for System Graphic Displays including overrides, alarm handling, scheduling, trends for critical values needing long-term or permanent monitoring via trends, and demand limiting.
- Install IP routers or ANSI/CEA-852 routers as needed to connect the building control network to the UMCS IP network. Routers shall be capable of configuration via DHCP and use of an ANSI/CEA-852 configuration server but shall not rely on these services for configuration. All communication between the UMCS and building networks shall be via the ANSI/CEA-709.1B protocol over the IP network in accordance with ANSI/CEA-852.

5.8.3.10. Provide the following to the Government for review prior to acceptance of the system:

- The latest version of all software and user manuals required to program, configure and operate the system.
- Points Schedule drawing that shows every DDC Hardware device. The Points Schedule shall contain the following information as a minimum:
 - Device address and NodeID.
 - Input and Output SNVTs including SNVT Name, Type and Description.
 - Hardware I/O, including Type (AI, AO, BI, BO) and Description.
 - Alarm information including alarm limits and SNVT information.
 - Supervisory control information including SNVTs for trending and overrides.
 - Configuration parameters (for devices without LNS plug-ins) Example Points Schedules are available at <https://eko.usace.army.mil/fa/besc/>
- Riser diagram of the network showing all network cabling and hardware. Label hardware with ANSI.CEA-709.1 addresses, IP addresses, and network names.
- Control System Schematic diagram and Sequence of Operation for each HVAC system.
- Operation and Maintenance Instructions including procedures for system start-up, operation and shut-down, a routine maintenance checklist, and a qualified service organization list.
- LONWORKS® Network Services (LNS®) database for the completed system.
- Quality Control (QC) checklist (below) completed by the Contractor's Chief Quality Control (QC) Representative

Table 5-1: QC Checklist

Instructions: Initial each item, sign and date verifying that the requirements have been met.		
#	Description	Initials
1	All DDC Hardware is installed on a TP/FT-10 local control bus.	
2	Communication between DDC Hardware is only via EIA 709.1B using SNVTs. Other protocols and network variables other than SNVTs have not been used.	
3	All sequences are performed using DDC Hardware.	
4	LNS Database is up-to-date and accurately represents the final installed system	
5	All software has been licensed to the Government	
6	M&C software monitoring displays have been created for all building systems, including all override and display points indicated on Points Schedule drawings.	
7	Final As-built Drawings accurately represent the final installed system.	
8	O&M Instructions have been completed and submitted.	
9	Connections between the UMCS IP network and ANSI/CEA-709.1B building networks are through ANSI/CEA-852 Routers.	
By signing below I verify that all requirements of the contract, including but not limited to the above, been met.		
Signature: _____ Date: _____		

5.8.3.11. Perform a Performance Verification Test (PVT) under Government supervision prior to system acceptance. During the PVT demonstrate that the system performs as specified, including but not limited to demonstrating that the system is Open and correctly performs the Sequences of Operation.

5.8.3.12. Provide a 1 year unconditional warranty on the installed system and on all service call work. The warranty shall include labor and material necessary to restore the equipment involved in the initial service call to a fully operable condition.

5.8.3.13. Provide training at the project site on the installed building system. Upon completion of this training each student, using appropriate documentation, should be able to start the system, operate the system, recover the system after a failure, perform routine maintenance and describe the specific hardware, architecture and operation of the system.

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5.8.4. TESTING, ADJUSTING AND BALANCING. Test and balance air and hydronic systems, using a firm certified for testing and balancing by the Associated Air Balance Council (AABC), National Environmental Balancing Bureau (NEBB), or the Testing Adjusting, and Balancing Bureau (TABB). The prime contractor shall hire the TAB firm directly, not through a subcontractor. Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB TABES, or SMACNA HVACTAB unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard shall be considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practicable to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations. All quality assurance provisions of the TAB Standard such as performance guarantees shall be part of this contract. For systems or system components not covered in the TAB Standard, the TAB Specialist shall develop TAB procedures. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are mandatory.

5.8.5. COMMISSIONING: Commission all HVAC systems and equipment, including controls, and all systems requiring commissioning for LEED Enhanced commissioning, in accordance with ASHRAE Guideline 1.1, ASHRAE Guideline 0 and LEED. Do not use the sampling techniques discussed in ASHRAE Guideline 1.1 and in ASHRAE Guideline 0. Commission 100% of the HVAC controls and equipment. Hire the Commissioning Authority (CA), certified as a CA by AABC, NEBB, or TABB, as described in Guideline 1.1. The CA will be an independent subcontractor to the contractor and not an employee or subcontractor of any other subcontractor on this project. The CA will not have business connections with any other party on the project. The CA will not have any other role or responsibilities outside of commissioning activities. The CA will communicate and report directly to the Government in the execution of the commissioning activities. The Contracting Officer's Representative will act as the Owner's representative in performance of duties spelled out under OWNER in Annex F of ASHRAE Guideline 0. All buildings with Minimum LEED Silver (or better) requirement will earn LEED Credit EA3 Enhanced Commissioning.

5.9. ENERGY CONSERVATION

5.9.1. The building including the building envelope, HVAC systems, service water heating, power, and lighting systems shall meet the Mandatory Provisions and the Prescriptive Path requirements of ASHRAE 90.1. Substantiation requirements are defined in Section 01 33 16, Design After Award.

5.9.2. Design all building systems and elements to meet the minimum requirements of ANSI/ASHRAE/IESNA 90.1. Design the buildings, including the building envelope, HVAC systems, service water heating, power, and lighting systems to achieve an energy consumption that is at least 40% below the consumption of a baseline building meeting the minimum requirements of ANSI/ASHRAE/IESNA Standard 90.1. Energy calculation methodologies and substantiation requirements are defined in Section 01 33 16, Design After Award.

5.9.3. Purchase Energy Star products, except use FEMP designated products where FEMP is applicable to the type product. The term "Energy Star product" means a product that is rated for energy efficiency under an Energy Star program. The term "FEMP designated product" means a product that is designated under the Federal Energy

Management Program of the Department of Energy as being among the highest 25 percent of equivalent products for energy efficiency. When selecting integral sized electric motors, choose NEMA PREMIUM type motors that conform to NEMA MG 1, minimum Class F insulation system. Motors with efficiencies lower than the NEMA PREMIUM standard may only be used in unique applications that require a high constant torque speed ratio (e.g., inverter duty or vector duty type motors that conform to NEMA MG 1, Part 30 or Part 31).

5.9.4. Solar Hot Water Heating. Provide at least 30% of the domestic hot water requirements through solar heating methodologies, unless the results of a Life Cycle Cost Analysis (LCCA) developed utilizing the Building Life Cycle Cost Program (BLCC) which demonstrates that the solar hot water system is not life cycle cost effective in comparison with other hot water heating systems. The type of system will be established during the contract or task order competition and award phase, including submission of an LCCA for government evaluation to justify non-selection of solar hot water heating. The LCCA uses a study period of 25 years and the Appendix K utility cost information. The LCCA shall include life cycle cost comparisons to a baseline system to provide domestic hot water without solar components, analyzing at least three different methodologies for providing solar hot water to compare against the baseline system.

5.9.5. Process Water Conservation. When potable water is used to improve a building's energy efficiency, employ lifecycle cost effective water conservation measures, except where precluded by other project requirements.

5.9.6. Renewable Energy Features. The Government's goal is to implement on-site renewable energy generation for Government use when lifecycle cost effective. See Paragraph 6, PROJECT SPECIFIC REQUIREMENTS for renewable energy requirements for this project.

5.10. FIRE PROTECTION

5.10.1. STANDARDS AND CODES Provide the fire protection system conforming to APPLICABLE CRITERIA.

5.10.2. Inspect and test all fire suppression equipment and systems, fire pumps, fire alarm and detection systems and mass notification systems in accordance with the applicable NFPA standards. The fire protection engineer of record shall witness final tests. The fire protection engineer of record shall certify that the equipment and systems are fully operational and meet the contract requirements. Two weeks prior to each final test, the contractor shall notify, in writing, the installation fire department and the installation public work representative of the test and invite them to witness the test.

5.10.3. Fire Extinguisher Cabinets: Provide fire extinguisher cabinets and locations for hanging portable fire extinguishers in accordance with NFPA 10 Standard for Portable Fire Extinguishers.

5.10.4. Fire alarm and detection system: Required fire alarm and detection systems shall be the addressable type. Fire alarm initiating devices, such as smoke detectors, heat detectors and manual pull stations shall be addressable. When the system is in alarm condition, the system shall annunciate the type and location of each alarm initiating device. Sprinkler water flow alarms shall be zoned by building and by floor. Supervisory alarm initiating devices, such as valve supervisory switches, fire pump running alarm, low-air pressure on dry sprinkler system, etc. shall be zoned by type and by room location.

5.10.5. Fire Protection Engineer Qualifications: In accordance with UFC 3-600-01, FIRE PROTECTION ENGINEERING FOR FACILITIES, the fire protection engineer of record shall be a registered professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveys (NCEES), or a registered P.E. in a related engineering discipline with a minimum of 5 years experience, dedicated to fire protection engineering that can be verified with documentation.

5.11. SUSTAINABLE DESIGN

5.11.1. STANDARDS AND CODES: Sustainable design shall conform to APPLICABLE CRITERIA. See paragraph 6, PROJECT-SPECIFIC REQUIREMENTS for which version of LEED applies to this project. The LEED-NC Application Guide for Multiple Buildings and On-Campus Building Projects (AGMBC) applies to all projects. Averaging may be used for LEED compliance as permitted by the AGMBC but is restricted to only those buildings included in this project. Each building must individually comply with the requirements of paragraphs ENERGY CONSERVATION and BUILDING WATER USE REDUCTION.

5.11.2. LEED RATING, REGISTRATION, VALIDATION AND CERTIFICATION: See Paragraph PROJECT-SPECIFIC REQUIREMENTS for project minimum LEED rating/achievement level, for facilities that are exempt from the minimum LEED rating, for LEED registration and LEED certification requirements and for other project-specific information and requirements.

5.11.2.1. Innovation and Design Credits. LEED Innovation and Design (ID) credits are acceptable only if they are supported by formal written approval by GBCI (either published in USGBC Innovation and Design Credit Catalog or accompanied by a formal ruling from GBCI). LEED ID credits that require any Owner actions or commitments are acceptable only when Owner commitment is indicated in paragraph PROJECT-SPECIFIC REQUIREMENTS or Appendix LEED Project Credit Guidance

5.11.3. OPTIMIZE ENERGY PERFORMANCE. : Project must earn, as a minimum, the points associated with compliance with paragraph ENERGY CONSERVATION. LEED documentation differs from documentation requirements for paragraph ENERGY CONSERVATION and both must be provided. For LEED-NC v2.2 projects you may substitute ASHRAE 90.1 2007 Appendix G in its entirety for ASHRAE 90.1 2004 in accordance with USGBC Credit Interpretation Ruling dated 4/23/2008.

5.11.4. COMMISSIONING. See paragraph 5.8.5 COMMISSIONING for commissioning requirements. USACE templates for the required Basis of Design document and Commissioning Plan documents are available at <http://en.sas.usace.army.mil> (click on Engineering Criteria) and may be used at Contractor's option.

5.11.5. DAYLIGHTING. Except where precluded by other project requirements, do the following in at least 75 percent of all spaces occupied for critical visual tasks: achieve a 2 percent glazing factor (calculated in accordance with LEED credit EQ8.1) OR earn LEED Daylighting credit, provide appropriate glare control and provide either automatic dimming controls or occupant-accessible manual lighting controls.

5.11.6. LOW-EMITTING MATERIALS. Except where precluded by other project requirements, use materials with low pollutant emissions, including but not limited to composite wood products, adhesives, sealants, interior paints and finishes, carpet systems and furnishings,

5.11.7. CONSTRUCTION INDOOR AIR QUALITY MANAGEMENT. Except where precluded by other project requirements, earn LEED credit EQ 3.1 Construction IAQ Management Plan, During Construction and credit EQ 3.2 Construction IAQ Management Plan, Before Occupancy.

5.11.8. RECYCLED CONTENT. In addition to complying with section RECYCLED/RECOVERED MATERIALS, earn LEED credit MR4.1, Recycled Content, 10 percent except where precluded by other project requirements.

5.11.9. BIOBASED AND ENVIRONMENTALLY PREFERABLE PRODUCTS. Except where precluded by other project requirements, use materials with biobased content, materials with rapidly renewable content, FSC certified wood products and products that have a lesser or reduced effect on human health and the environment over their lifecycle to the maximum extent practicable.

5.11.10. FEDERAL BIOBASED PRODUCTS PREFERRED PROCUREMENT PROGRAM (FB4P). The Farm Security and Rural Investment Act (FSRIA) of 2002 required the U.S. Department of Agriculture (USDA) to create procurement preferences for biobased products that are applicable to all federal procurement (to designate products for biobased content). For all designated products that are used in this project, meet USDA biobased content rules for them except use of a designated product with USDA biobased content is not required if the biobased product (a) is not available within a reasonable time, (b) fails to meet performance standard or (c) is available only at an unreasonable price. For biobased content product designations, see <http://www.biopreferred.gov/ProposedAndFinalItemDesignations.aspx>.

5.12. CONSTRUCTION AND DEMOLITION (C&D) WASTE MANAGEMENT: Achievement of 50% diversion, by weight, of all non-hazardous C&D waste debris is required. Reuse of excess soils, recycling of vegetation, alternative daily cover, and wood to energy are not considered diversion in this context, however the Contractor must track and report it. A waste management plan and waste diversion reports are required, as detailed in Section 01 57 20.00 10, ENVIRONMENTAL PROTECTION.

5.13. SECURITY (ANTI-TERRORISM STANDARDS): Unless otherwise specified in Project Specific Requirements, only the minimum protective measures as specified by the current Department of Defense Minimum

Antiterrorism Standards for Buildings, UFC 4-010-01, are required for this project. The element of those standards that has the most significant impact on project planning is providing protection against explosives effects. That protection can either be achieved using conventional construction (including specific window requirements) in conjunction with establishing relatively large standoff distances to parking, roadways, and installation perimeters or through building hardening, which will allow lesser standoff distances. Even with the latter, the minimum standoff distances cannot be encroached upon. These setbacks will establish the maximum buildable area. All standards in Appendix B of UFC 4-010-01 must be followed and as many of the recommendations in Appendix C that can reasonably be accommodated should be included. The facility requirements listed in these specifications assume that the minimum standoff distances can be met, permitting conventional construction. Lesser standoff distances (with specific minimums) are not desired, however can be provided, but will require structural hardening for the building. See Project Specific Requirements for project specific siting constraints. The following list highlights the major points but the detailed requirements as presented in Appendix B of UFC 4-010-01 must be followed.

- (a) Standoff distance from roads, parking and installation perimeter; and/or structural blast mitigation
- (b) Blast resistant windows and skylights, including glazing, frames, anchors, and supports
- (c) Progressive collapse resistance for all facilities 3 stories or higher
- (d) Mass notification system (shall also conform to UFC 4-021-01, Mass Notification Systems)
- (e) For facilities with mailrooms (see paragraph 3 for applicability) – mailrooms have separate HVAC systems and are sealed from rest of building

6.0 PROJECT SPECIFIC REQUIREMENTS

6.1. GENERAL

The requirements of this paragraph augment the requirements indicated in Paragraphs 3 through 5.

6.2. APPROVED DEVIATIONS

The following are approved deviations from the requirements stated in Paragraphs 3 through 5 that only apply to this project.

No Central Cooling Plant is required for this project.

6.3. SITE PLANNING AND DESIGN

6.3.1. General:

Refer to the Site Plans (See Appendix J) for proposed locations of improvements to be included under this scope of work. The site is located at the corner Marshall St. and Madison Ave. The facility shall be sited to comply with all force protection requirements as well as allow for the future development of the site. The Design Build (D/B) contractor shall be responsible for all site improvements within the designated construction limits indicated on the site plans.

6.3.2. Site Structures and Amenities

The proposed development will consist of a dining facility building pad, a 300 man barracks building with service drive, a 2,000 square foot maintenance building, a covered assembly area, and a quarter mile running track with four interior sand exercise pits with the associated climbing bars and sidewalks providing connectivity to the site as shown on the site plans located in appendix J. The site plans have allotted locations and the associated coordinates where the barracks and track are to be located to ensure functionality with the future site development.

The running track shall be constructed in accordance with the layout and cross section provided in Appendix J, Attachment C. In addition, provide an under drain system for the track consisting of a minimum of a UD-4 edge drain running concentric with and around the entire perimeter of the track, surrounded by a minimum of 6" of VDOT No. 57 Stone. The under drain system at the track perimeter shall be connected to and drain into the under drain system shown on the site plans beneath the PT pits in the center of the running track.

A concrete dumpster pad shall be provided and shall extend a minimum of 20 feet in front of dumpster to accommodate the trash truck front wheels. Dumpster screen wall enclosures will be provided. The screen wall enclosures will visually match or be constructed of materials to match the new facility exterior walls. The color will match the new facility exterior wall. A gate keeper, capable of holding the gates in an open position, and a locking mechanism will be integrated into the gate design. Gates will have a minimum width of 12 feet. Dumpster locations will comply with criteria listed in Paragraph 4. Recycling space shall be incorporated into the site design adjacent to the dumpster pad.

Provide exterior signage, building numbers (provided by the DPW Real Property Office to the USACE Project Manager), in accordance with Appendix H.

The construction site will be enclosed by fencing throughout the duration of work to warn people passing near or trying to pass through the site. Barricades and signs shall be posted at project areas while work is in progress to

ensure safety of personnel entering or working in the area. Upon completion of construction, all construction area and safety fence, barricades and signs will be removed from the Installation by the Contractor. The construction fencing must be provided with brown vertical metal slats. Diagonal slats and/or fabric are not acceptable. Slats must be installed such that the tops are even.

6.3.3. Site Functional Requirements:

6.3.3.1. Stormwater Management (SWM) Systems.

(a) During the design of the site, Fort Eustis's storm water management measures are to be taken into consideration per Virginia Pollution Discharge Elimination System (VPDES). The site design is to incorporate strategies including a combination of structural practices, standards, and specifications that are appropriate for the site. The design shall consider long-term operation and maintenance of BMP's. Water quality protection will be considered in accordance with the Federal Clean Water Act, Virginia Code §§ 62.1-44.15 through 44.30, and Virginia Administrative Code 9 VAC 25-30-10 et seq.

(b) A Storm Water Pollution Prevention Plan that uses BMP's for erosion and sediment control will be developed in accordance with the Virginia Stormwater Management Handbook and Fort Eustis's integrated stormwater pollution prevention plan. The contractor shall address these issues early in the design process to accommodate the review and approval process without delaying construction activities.

(c) The DB Contractor shall ensure that work does not interrupt the flow of storm water nor interfere with the daily operations of the Installation.

(d) Damages to the existing system must be corrected for final acceptance of the project.

(e) Fort Eustis DPW is developing comprehensive storm water management policies that include, among other things, the following requirements:

1. Site designs shall minimize the generation of storm water and maximize pervious areas for storm water treatment. Structural and nonstructural infiltration BMPs shall be encouraged to provide storm water quality and quantity control and groundwater recharge.

2. Natural channel characteristics shall be preserved to the maximum extent practicable.

3. The use of low-impact development (LID) site planning and integrated management practices shall be encouraged to control storm water runoff at the source and more closely approximate predevelopment runoff conditions.

(f) State and Federal design manuals that address proper storm water management design techniques, including the following:

1. Virginia Stormwater Management Handbook, Volumes I and II, prepared by the Virginia Department of Conservation and Recreation dated 1999, as amended.

2. VDOT Drainage Manual, prepared by the Hydraulics Section of the Virginia Department of Transportation dated 2002, as amended.

3. Virginia Erosion and Sediment Control Handbook, prepared by the Virginia Department of Conservation and Recreation dated 1992, as amended.

4. Low Impact Development Design Strategies: An Integrated Design Approach, United States Environmental Protection Agency, Office of Water, EPA 841-B-00-003 dated June 1999, as amended.

5. Low Impact Development Hydrologic Analysis, United States Environmental Protection Agency, Office of Water, EPA 841-B-00-002 dated June 1999, as amended.

The manuals referenced here should be used by designers to ensure that standard, acceptable design practices are used to develop their storm water management designs.

Stormwater management calculations must be provided according to the Virginia Stormwater Management Handbook. Stormwater Calculations must prove, at a minimum, that the proposed development will not increase runoff for the 2 and 10 year design storms. The D/B contractor is responsible for designing any required detention facilities. The contact for all stormwater issues is Susan Miller with the DPW/ENRD. Her contact information is as follows: Phone (757) 878-4123x302 Email [HYPERLINK "mailto:susan.p.miller@us.army.mil"susan.p.miller@us.army.mil](mailto:susan.p.miller@us.army.mil).

6.3.3.2. Erosion and Sediment Control

A Storm Water Pollution Prevention Plan that uses BMP's for erosion and sediment control will be developed in accordance with the Virginia Stormwater Management Handbook and Fort Eustis's integrated stormwater pollution prevention plan. Erosion and sediment control measures such as silt fence, inlet protection and temporary sediment traps may be required. The Design/Build Contractor shall apply for a Land Disturbance Permit early in the design process to accommodate the review and approval process without delaying construction activities.

Contractor shall install stabilized construction entrances in accordance with the Virginia Erosion and Sediment Control Handbook. Contractor shall also minimize tracking soil onto adjacent roadways. Contractor shall sweep roadways as necessary to remove tracked soil and dust.

6.3.3.3. Vehicular Circulation.

The D/B Contractor shall provide a facility that will accommodate uninterrupted flow on Marshall St. and Madison Ave. Marshall St. shall remain open for both pedestrian and vehicular traffic throughout the project. The construction entrance shall be off Madison Ave as indicated on the site plans in appendix J. The Contractors laydown area is also indicated on the plans in appendix J.

6.4. SITE ENGINEERING

6.4.1. Existing Topographical Conditions

See Existing Conditions Plans in Appendix J. Any discrepancies which are found in the furnished plans shall be brought to the attention of the Contracting Officer. The proposed site for the AIT facility is a relatively flat site which was previously a housing development which has since been demolished. Crossing this site is a large communication duct bank that will remain in place as well as a 48" storm sewer that will be relocated on site by the Design/Build Contractor during this phase.

6.4.2. Existing Geotechnical conditions: See Appendix A for a preliminary geotechnical report.

A Preliminary Geotechnical Report including a boring location map and a description of subsurface conditions was prepared by Froehling & Robertson, Inc. in January 2010 and is included in Appendix A.

6.4.3. Fire Flow Tests See Appendix D for results of fire flow tests to use for basis of design for fire flow and domestic water supply requirements.

See Appendix D for results of preliminary fire flow tests to use for basis of design for fire flow and domestic water supply requirements. The Contractor shall conduct fire flow tests to be used for the final design and construction of the fire protection system.

6.4.4. Pavement Engineering and Traffic Estimates:

Building Aprons: Pavement design for aprons and roadways will be designed in accordance with UFC 3-250-01FA and the contractor's final geotechnical study. Concrete pavements shall be in accordance with UFC 3-250-04FA.

Pavement Design:

(a) The D/B Contractor shall provide pavements designed for the anticipated vehicle traffic of the heaviest wheeled vehicle and in accordance with UFC 3-250-01FA and using the PCASE program. The pavement design will be based on a minimum of 20 years of projected traffic.

(b) Materials and construction will conform to the most recent edition of the VDOT Road and Bridge Specifications book.

The subgrade will be prepared and compacted in accordance with the geotechnical report and the most recent edition of the VDOT Road and Bridge Specifications book. The geotechnical report contained within Appendix A is for information only. The Contractor shall provide a final geotechnical report for the basis of design.

6.4.5. Traffic Signage and Pavement Markings

There are no additional requirements.

6.4.6. Base Utility Information

6.4.6.1 EXISTING UTILITY LOCATIONS

Existing utilities must be located before doing any digging work on the Facility. The Contractor shall be responsible to contact Miss Utility, obtain all existing utility locations which may be necessary to accomplish his work, and mark any utility lines in the immediate vicinity of his work. It shall be the responsibility of the Contractor to contact Miss Utilities at 1-800-552-7110 for locating commercial utilities 48 hours prior to digging operations. The existing communications duct bank shall not be disturbed during construction of the AIT facility.

6.4.6.2 UTILITY CONNECTIONS

(a) Connections to existing or extended utilities will be coordinated with Fort Eustis DPW and the privatized utility company. In addition to the contacts listed in the following paragraphs, a complete listing of contact information for utility companies serving Fort Eustis is included in Appendix C

(b) The Contractor shall schedule the work so as to cause as little interruption of utility services as possible during normal work day hours, 0700 to 1630 hours Monday through Friday. ALL utility interruptions shall be coordinated with the Contracting Officer. The Contractor shall provide no less than 15 days notice of intended utility interruption to the Contracting Officer. Water and electrical services shall be terminated only as necessary, and shall be restored at the end of each working day. Temporary water and electrical services shall be provided if interruption will last more than four hours.

(c) Refer to Appendix BB for Fort Eustis DPW Utility SOPs.

6.4.6.3 SANITARY SEWER SYSTEM

(a) The Sanitary Sewer System at Ft. Eustis has been privatized and is owned by Old Dominion Utility Services Inc. (ODUS). ODUS point of contact for this project is Julie Ball at (757) 621-1371 or via email at [HYPERLINK "mailto:balljm@obg.com" balljm@obg.com](mailto:balljm@obg.com).

(b) A sanitary sewer system, outside the five-foot building line, will be designed and constructed by ODUS to convey wastewater to the Fort Eustis wastewater collection system. The point of connections with the existing sewer system shall be determined by ODUS through coordination with the Fort Eustis Directorate of Public Works/Directorate of Logistics (DPW) point of contact, Arlene Day and the site designer.

(1) All work for construction or relocation of the sanitary sewer shall be performed by ODUS to a point 5 feet from the proposed building including abandonment and filling of existing sanitary sewers and manholes with concrete, providing new sanitary sewers, two way cleanouts and connection to existing manhole. Contractor shall make final connection to work by ODUS and provide required flushing and testing of the system to the point of that connection.

(2) The Contractor shall determine the sewerage contribution for the facility and shall provide information to ODUS. The Contractor shall prepare the design of the building sewer system and shall coordinate with ODUS connection to the sanitary system being installed by ODUS.

(3) Costs or fees assessed by ODUS for the design and construction of or connection to the sanitary sewer system shall be paid to ODUS by the Government from construction funds for this project.

6.4.6.4 WATER SYSTEM

- (a) The Water System at Ft. Eustis has been privatized and is owned by Old Dominion Utility Services Inc. (ODUS). ODUS point of contact for this project is Julie Ball at (757) 621-1371 or via email at HYPERLINK "mailto:balljm@obg.com" balljm@obg.com.
- (b) ODUS will be responsible for the design and construction of the water distribution system to the building tap/meter point five feet outside the building line. Payment to ODUS for design and construction of the water distribution system will be paid to ODUS by the Government from construction funds for this project.
- (c) The Design Build Contractor is responsible for the design and construction of the building water system inside of the five-foot line around the building, including the connection to the main distribution system provided by ODUS. The DB Contractor shall coordinate capacities and connection points with the Contracting Officer and with ODUS.
- (d) All water lines will comply with applicable Local, State (VDH) and Federal UFC standards as listed in Paragraph 4. Local and State standards will dictate unless the Federal standards are more stringent.
- (e) All new water lines and any existing lines which do not remain fully pressurized during construction or connection will be disinfected. The disinfection will be in accordance with the American Water Works Association Standard AWWA C651 and will not be complete until two consecutive days of bacteriological samples show no contamination. All bacteriological, lead and copper tests will be performed by Environmental Protection Agency (EPA) certified laboratories.

6.4.6.5 NATURAL GAS

- (a) The natural gas utility service at Fort Eustis has not been privatized. Natural gas is currently provided to Fort Eustis by Virginia Natural Gas (VNG). VNG point of contact for this project is Robert Deaver of Virginia Natural Gas at (757) 455-5361 or via email at HYPERLINK "https://ff.cecer.army.mil/FCKeditor/editor/%22%22mailto:rdeaver@aglresources.com%22%22" rdeaver@aglresources.com.
- (b) The DB Contractor shall coordinate the anticipated natural gas demand with Fort Eustis DPW and with VNG.
- (c) Fort Eustis DPW in coordination with VNG is responsible for the design and construction of the natural gas system from the connection with the main to the gas meter.
- (d) The DB Contractor is responsible for the design and construction of the natural gas distribution from the meter to each point of use within the building. All natural gas systems shall be designed constructed in accordance with UFC and Local, State, and Federal standards as listed in Paragraph 4. Local and State standards will dictate unless the Federal standards are more stringent.

6.4.6.6 ELECTRICAL SERVICE

- (a) The electrical infrastructure system at Fort Eustis has been privatized and is owned by Dominion Virginia Power (DVP). DVP point of contact for this project is Steve Buell of Dominion VA Power at (757) 434-6195 or via email at HYPERLINK "https://ff.cecer.army.mil/FCKeditor/editor/%22%22mailto:steve.buell@dom.com%22%22" steve.buell@dom.com.
- (b) The DB Contractor will coordinate all electrical service connections with the Dominion Virginia Power privatized utility group. Submission of load letters and documentation supporting the site location of transformers and metering equipment will also be coordinated and approved.

(c) The DB Contractor is responsible for the design and construction of the electrical systems from the five-foot building line into and within the building. All electrical systems shall be designed constructed in accordance with UFC and Local, State, and Federal standards as listed in Paragraph 4. Local and State standards will dictate unless the Federal standards are more stringent.

(d) The DB Contractor shall design the exterior building lighting system including walkway lighting. The DB Contractor shall provide and install lighting fixtures that are mounted on/attached to the building. The DB Contractor shall also design the sidewalk, running track and exercise pit lighting systems. Lighting fixtures and levels shall be in accordance with UFC and IES recommendations and requirements stated within this RFP. The DB Contractor shall coordinate all lighting designs with Dominion Virginia Power.

6.4.6.7 COMMUNICATIONS SERVICE

(a) The communications infrastructure system at Fort Eustis has not been privatized and is managed by the Fort Eustis Network Engineering Command (NEC). NEC point of contact for this project is Bob Beil of NEC (Network Engineering Command) at (757) 878-1133 or via email at HYPERLINK "mailto:bob.biel@us.army.mil" bob.biel@us.army.mil.

(b) The DB Contractor will contact and coordinate all communications service connections with NEC.

(c) All communications systems, outside plant (OSP), voice system, and data network shall be designed and constructed in accordance with the USAISEC Technical Guide for Installation, Information, Infrastructure, Architecture (I3A), or as directed by the NEC requirements.

(d) The DB Contractor shall coordinate communication infrastructure design and construction requirements with the NEC and USAISEC Site Engineer through the Corps of Engineers, Resident Engineer or other COE POC as designated. Construction drawings and specifications shall comply with UFC-3-580-2 and be coordinated with USAISEC, Fort Detrick Engineering. (For a copy of the I3A Guide, contact USAISEC-FDED, email: DetrickISECI3Aguide@conus.army.mil.)

(e) The DB Contractor is responsible for the design and construction of the communications systems within the building and from the building to the connection point with the installation infrastructure. The DB Contractor shall engineer, furnish, install, secure, and test (EFIS&T) the telecommunications and information technology infrastructure and make operational.

(f) The DB contractor shall refer to communication systems in paragraph 6.9.3 for additional building distribution and design information

6.4.6.8 TRACER WIRE AND MARKER TAPE

All non-metallic utility and storm drain lines will have #12 AWG TW (thermal-weather resistant) insulated, solid copper wire, installed parallel with and 6 inches above the utility for the reception of a locator transmitter signal. In addition, natural gas lines will have marking tape placed in the trench 6 inches below finish grade.

No additional Site Base Electrical Utility information.

No additional Site Base Water Utility information.

No additional Site Base Sewer Utility information.

No additional Site Base Gas Utility information.

No additional Site Base Cable TV Utility information.

6.4.7. Cut and Fill

Place all fill in a manner consistent with the recommendations of the geotechnical engineer. Fill placed beneath the building and pavements shall be compacted structural fill and shall consist of material SP, SP-SM, or SM with maximum 35% fines with PI less than 35 (as defined by the ASTM D 2487-98). Fill/Backfill placed within a minimum of 5 feet beyond the buildings or pavements footprints or to a distance at least equal to the height of the maximum fill depth shall be properly placed, compacted, controlled structural fill. The fine grained soils encountered at the projects location are more sensitive to moisture contents higher or lower than optimum moisture content. Materials classified as CH and MH are unsatisfactory for utility backfill or for any fill in building areas. Materials classified as OH, OL, and PT are unsatisfactory in-situ and as fill of any kind. All fill/backfill materials including base and gravel layers shall be placed in suitable thickness to achieve compaction based on the compaction equipment used. Maximum loose lift thickness shall not exceed 8".

Soil compaction shall be achieved by equipment well suited to the type and condition of materials being compacted and as approved by a professional geotechnical engineer. Material shall be moistened or aerated as necessary, but in no case to more than 3 percent plus or minus from optimum, to provide the moisture content that will readily facilitate obtaining the compaction specified with the equipment used. Compact subgrade materials, each layer of fill beneath structures, and pavement sub-base to not less than 95% of ASTM D-1557 maximum laboratory density for cohesive and cohesionless soils.

The following minimum testing requirements for subgrade, fill, backfill and aggregate base materials shall be incorporated into project specifications:

- a) A minimum of one moisture density test (ASTM D1557) shall be preformed for each on-site or borrow soil material.
- b) One Atterberg Limits test (ASTM D 4318) and one gradation analysis (ASTM D 422) shall be preformed for every ten field density test.
- c) A minimum of one sand cone field density test (ASTM D 1556 or ASTM D 6938) shall be performed on compacted subgrade and on each layer or fill/backfill/base at minimum frequencies of:
 - i. One test per column footing and per 100 feet of foundation wall.
 - ii. One test per 100 feet of utility trench.
 - iii. One test per 2000 square feet of building area, and per 4000 square feet for all other areas.

These requirements shall be verified or betterments recommended by the consulting professional geotechnical engineer in the report wherever engineering, solid, or climatic factors indicate the necessity. These requirements shall also be verified to be consistent with the selected foundation system. Any modifications to the stated compaction requirements shall be supported by engineering analysis and shall require the approval of the contracting officer. The final approved requirements shall be specified and/or shown in the final contract submission documents.

6.4.8. Borrow Material

The site will require the use of controlled structural fill. Off-site borrow soils required to bring the site to final grade or backfill below grade structures and utility trenches shall be approved by the government before use. The D/B Contractor's geotechnical engineer shall approve the installation of all fill materials.

6.4.9. Haul Routes and Staging Areas

The Contractor will be allowed to use Fort Eustis road system for transporting construction materials and debris to and from the project sites. Care shall be taken to minimize "tracking" of mud from the project sites with regular cleaning of equipment and street cleaning. The route for hauling of such material and debris shall be coordinated with Fort Eustis DPW prior to the start of construction.

6.4.10. Clearing and Grubbing:

Clearing and grubbing shall be done with care not to disturb the legacy trees that are to remain on site. The top soil shall be stripped and stockpiled on site. All organic material shall be removed from material that will be used as fill. Excess material such as stockpiled dirt, Cleared trees and vegetation shall be removed from government property at the D/B contractor's expense.

6.4.11. Landscaping:

Existing healthy vegetation shall be saved to the greatest extent possible, and protected during the construction process per the Tree Protection Standard 3.38 of the *Virginia Erosion and Sediment Control Handbook, 1992*. A concerted effort should be made to save as many legacy trees as is feasible throughout the course of design, demolition, and construction. Existing vegetation that does not conform to the Anti-Terrorism Force Protection (ATFP) requirements shall be removed.

The planting plan will address functional uses foremost and secondarily on aesthetics. Plants shall be selected that require minimal maintenance. In order to comply with LEED Credit WE 1.2, *Water Efficient Landscaping*, the landscaping plan will focus on the selection of plant species that are drought tolerant. Also, trees and shrubs shall be selected that can be commonly procured locally to conform to the requirements of LEED Credit MR 5, *Regional Materials*.

Plant selection and location shall be in accordance with the **ATFP Standard 2 – Unobstructed Space**, which states the following: Landscaping and other site features within 33 feet (10m) of the building will be designed such that explosive devices would be visually detected by building occupants. No landscaping or other feature within 33 feet will allow concealment of any object six inches or greater in height.

The landscape plan shall adhere to the Ft. Eustis Installation Design Guide Landscaping Requirements. Trees shall be located at least 30 feet from the proposed running track to avoid accumulation of leaf litter and debris on the running surface. Shrubs will be planted in mulch beds consisting of 3" thick layer of mulch. Trees will have a 3' radius of 3" mulch around the base of the tree.

6.4.12. Turf:

The Contractor shall be responsible for establishment of turf over disturbed areas of the project limits. Turf shall be in accordance with the grasses indicated in the Appendix I and shall be approved by Fort Eustis Environmental Office

Seed mix **MUST** be approved by Forestry Manager to meet seasonal needs.

Refer to Appendix I for information regarding turf.

6.5. ARCHITECTURE

6.5.1. General: To the maximum extent possible within the contract cost limitation, the buildings shall conform to the look and feel of the architectural style and shall use the same colors as adjacent facilities as expressed herein. The Government will evaluate the extent to which the proposal is compatible with the architectural theme expressed in the RFP during the contract or task order competition. The first priority in order of importance is that the design provides comparable building mass, size, height, and configuration compared to the architectural theme expressed herein. The second priority is that design is providing compatible exterior skin appearance based upon façade, architectural character (period or style), exterior detailing, matching nearby and installation material/color pallets, as described herein.

6.5.2. Design

6.5.2.1. Appendix F is provided "For Information Only", to establish the desired site and architectural themes for the area. Appendix F identifies the desired project look and feel based on Fort Eustis's Installation Architectural Theme from existing and proposed adjacent building forms; i.e. building exterior skin, roof lines, delineation of entrances, proportions of fenestration in relation to elevations, shade and shadow effects, materials, textures, exterior color schemes, and organizational layout.

6.5.2.2. The design should address Fort Eustis's identified preferences. Implement these preferences considering the following:

- (a) Achievable within the Construction Contract Cost Limitation (CCL)
- (b) Meets Milestones within Maximum Performance Duration.
- (c) Achieves Full Scope identified in this Solicitation
- (d) Best Life-Cycle Cost Design
- (e) Meets the Specified Sustainable Design and LEED requirements
- (f) Complies with Energy Conservation Requirements Specified in this RFP.

6.5.2.3. Priority #1. Visual Compatibility: Facility Massing (Size, Height, Spacing, Architectural Theme, etc.) Exterior Aesthetic Considerations: The buildings massing, exterior functional aesthetics, and character shall create a comprehensive and harmonious blend of design features that are sympathetic to the style and context of the Installation. The Installation's intent for this area is:

The conceptual aesthetic considerations shall be in conformity with the Ft. Eustis Design Guidelines. The exterior shall closely resemble the architectural style of the DFAC, JTFCS and TRADOC facility on base. Contractor shall take into consideration the architectural style and features of the DFAC Facility which is currently under design and will be located next to the Barracks. A colored elevation of the DFAC Facility is included in Appenix F. The building shall include a standing seam metal roof and a brick exterior.

6.5.2.4. Priority #2. Architectural Compatibility: Exterior Design Elements (Materials, Style, Construction Details, etc.) Roofs, Exterior Skin, and Windows & Door Fenestrations should promote a visually appealing compatibility with the desired character while not sacrificing the integrity and technical competency of building systems.

6.5.2.5. See Appendix F for exterior colors that apply to Architectural character at Fort Eustis. The manufacturers and materials referenced are intended to establish color only, and are not intended to limit manufacturers and material selections.

6.5.2.6. Additional architectural requirements:

- (a) Install fall protection anchor points on all roofs with a slope greater than 2:12

Facility Description: A three-story 300-soldier standard Enlisted Barracks / Company Operations Facility shall be constructed at approximately 92,800 square feet. This facility shall be constructed using the Center of Standardizations standard design.

Accessibility: The development shall be designed to accommodate an accessible route throughout the site, to each of the new facilities. The 300-soldier Barracks / Company Operations Facility shall be constructed in accordance with the Center of Standardization standard design which currently provides accessible spaces within the first floor offices and operations spaces; however, does not provide for accessible sleeping quarters or toilet facilities. This standard design currently meets the installation needs at Fort Eustis, Virginia.

Building Components: The proposed exterior architectural design for the AIT Complex Phase 1 Facilities shall use the Ft. Eustis Installation Design Guide for help in material selections.

The exterior wall construction of the Barracks shall be in accordance with the appropriate Center of Standardization specifications. For this design, the exterior is expected to consist of brick veneer and select areas of glazed curtain wall. The building envelope shall be insulated per ASHRAE 90.1 and as required to achieve LEED Silver Certification in combination with other credits.

High-sloped roofs will be bronze colored standing seam metal with concealed fasteners, typical to other facilities on the post. Low sloped roofs shall be a hybrid system consisting of a white granular-surfaced, modified bitumen (SBS) cap sheet over (2) layers of felt in a hot-mopped application. Roof structures shall be in accordance with the standard designs.

Exterior doors shall be flush, insulated hollow metal in hollow metal frames. All exterior doors and frames shall be galvanized. Interior doors and frames shall be in accordance with the appropriate standard designs. All door locks must be able to accept Best Lock cores.

Window units and storefronts will be fabricated of standard 4" deep, center-glazed aluminum storefront sections. All window frames are designed as fixed units with a thermal break. Operable windows are prohibited below 10-feet above finished grade in accordance with Anti-Terrorism / Force Protection requirements. Window finish on aluminum frames will be a fluoropolymer coating. Windows will be designed in accordance with force protection requirements. Frames will be anchored to the supporting construction to insure the frames do not separate from the walls, as required by AT/FP regulations.

Glazing for all exterior windows will consist of 1" thick insulated glazing units. The outer pane will consist of 1/4" float glass. The inner pane will consist of 1/4" laminated, clear glass with a low-E coating on the #3 surface.

Additional Architectural Requirements:

Use of spray polyurethane foam (SPF) in the building envelope shall comply with the appropriate standards and codes for the selected assemblies. The application of spray polyurethane foam (SPF) directly to the face of precast concrete panels is prohibited.

- All materials for flashing and sheet metal trim; including gutters, downspouts, fascias, soffit, and trim shall be prefinished metal to match the roof; comply with SMACNA Architectural Sheet Metal Manual; and shall be provided with the manufacturers standard finish warranty. Trim and flashing shall be at least 26 gauge 55% Aluminum-Zinc alloy coated sheet steel in compliance with ASTM B 209 with a factory applied, oven baked, polyvinylidene fluoride resin finish, with no exposed fasteners. Soffits other than entry canopies shall be flush panels. Continuous wood backing shall support fascia. Metal trim and flashing shall be produced in the maximum practical lengths but in no case less than ten feet long. Trim shall be flat with no oil canning or waves. All exposed flashing must match the roof color.
- Joint Sealant. Sealants shall be compatible and as recommended by the manufacturer of the items being sealed. Sealant at masonry shall be a one or two part urethane and shall match the color used for the Central Campus Part I facilities currently under construction. Sealant at window and door frames shall be a one or two part urethane and shall match the color used for the Central Campus Part I facilities currently under construction. Interior joint sealant shall be silicone and be clear or match the surface being sealed. Compatible primers and backer rods shall be used with sealant.
- Brick shall be severe weather rated, ASTM C 216/652.
- Concrete Masonry Units (CMU) shall be ASTM C90, may be lightweight units. Masonry work shall comply with the Brick Institute of America and American Concrete Institute guidelines. Masonry veneer shall be anchored to the structural substrate with galvanized adjustable wall ties. Steel lintels, if used, shall be hot dipped galvanized steel and painted. All masonry at windows and doors and wall/grade intersections shall be flashed with a flexible metal flashing. Exterior CMU walls shall be damp proofed above grade and above interior finished floor line.
- Insulation shall be provided in exterior walls, floors, and roof/ceiling assemblies with thermal transmittance (U-values) which comply with Applicable Criteria identified in Paragraph 4 of this RFP. Perimeter Slab Insulation. Insulation shall be un-faced preformed rigid expanded polystyrene.
- Exterior Insulation Finish System (EIFS) shall not be used on buildings at Fort Eustis.
- Fort Eustis Fire Department requires the Knox Box (provided by the Contractor) be located at the front entry. The Contractor shall contact the Fire Department through the Contracting Officer to obtain order information and forms for the Knox Box.

6.5.3. Programmable Electronic Key Card Access Systems:

Programmable key card systems are not required for this facility.

6.5.4. INTERIOR DESIGN

No additional interior design requirements are necessary.

Interior building signage requirements:

No additional interior design signage is required.

6.6. STRUCTURAL DESIGN

Structural Requirements General: Design of the buildings included in Phase 1 of the AIT Complex will be based on a COS Standard design, with structural systems designed to incorporate local site conditions and loading requirements.

The barracks is approximately 92,800 square feet, including three levels of resident rooms and a single story administrative area. The residence hall portion of the building contains 50 resident rooms, and associated mechanical spaces, day rooms, lobbies, etc. on each level. The single story administrative area includes offices, supplies storage, arms vault, and an assembly area.

Foundations: The barracks building will be supported by a deep foundation consisting of pre-cast concrete or auger cast in place concrete piles. Pile capacities ranging from approximately 50 kips to approximately 100 kips can be achieved using precast or auger cast in place piles with tip elevations 50 to 60 feet below existing finished grade. Interior and exterior bearing walls will be supported on reinforced concrete grade beams designed to span between pile supported footings. For stability, footings will typically be supported by a minimum of 2 piles. First floor construction will consist of reinforced concrete slabs on grade placed over a stone sub base and vapor barrier. Slabs on grade will be reinforced with welded wire reinforcement and will include construction and control joints appropriately designed and spaced to alleviate cracking associated with expansion and contraction, and with isolation joints around columns, bearing walls, and exterior walls to accommodate minor movements without damage. Slabs below interior non-bearing masonry walls will be thickened to support the additional weight of the masonry construction.

Loading dock retaining walls will be constructed of reinforced concrete, designed to resist lateral earth pressures determined during a site specific geotechnical investigation.

Structural System:

The structural system at the three level residence hall portion of the barracks building shall consist of hollow core pre-cast concrete planks at the second and third floors and roof levels, supported by concrete masonry bearing walls. Concrete planks will span parallel to the long axis of the residence hall corridors and, in general will bear on alternate resident room walls. Structural steel headers will support ends of concrete planks over corridors and in common areas where bearing walls are discontinuous. The building structural system shall be designed in accordance with the requirements of the AT/FP requirements of UFC 4-010-01. Specifically, in addition to other AT/FP requirements mentioned elsewhere, the barracks building structural system shall be designed to comply with the Progressive Collapse Avoidance requirements of the referenced standard. Exterior walls will be cavity walls consisting of 4" facing brick or CMU, cavity, and 8" reinforced concrete masonry. Interior bearing walls will be constructed of 8" reinforced concrete masonry. Lateral wind and seismic loads will be resisted by reinforced masonry shear walls in the long and short directions of the building. Storefront and window glazing systems will be designed to resist specified wind and seismic loads and to withstand the overpressure loading requirements indicated in UFC 4-010-01. Surrounding building structural elements and connections shall be designed to withstand wind, seismic, and blast pressure loads applied to glazing systems.

The structural system at the single level portion of the barracks building shall consist of a structural steel frame. The roof construction will include min. 20Ga 1½" galvanized steel wide rib roof deck supported by open web steel joists. Joists will be supported by structural steel wide flange girders and columns. Lateral wind and seismic loads at the single story portion of the barracks building will be resisted by ordinary steel moment frames. Exterior walls

will be cavity walls consisting of a 4" thick facing brick or CMU wythe, a cavity, and 8" reinforced concrete masonry backup wythe.

The building shall be designed in accordance with the loading requirements of the International Building Code (IBC) 2006 and applicable UFC requirements:

Live Loads

Resident Rooms Above First Floor	60 psf
Common Areas and Corridors above First Floor	100 psf
First Floor Areas/Mechanical/Electrical Rooms	150 psf
Centralized Laundry Area	150 psf (but not less than actual equipment loads)
Roof	20 psf
Collateral	10 psf

Wind Loads

Basic Wind Speed, V	105 mph
Exposure Category	C
Importance Factor, I	1.15

Snow Loads

Ground Snow Load, Pg	20 psf
Exposure Factor, Ce	1.0
Thermal Factor, Ct	1.1
Importance Factor, I	1.1

Seismic Loads

Ss	15% g
S1	5% g

Site Soil Classification E

Importance Factor, I 1.25

Lateral Stability: As referenced in Section 01 33 16, 3.5.2.3(b): Describe the method and provide construction details to develop lateral stability systems for the Architectural, Structural, Mechanical, Electrical, Plumbing, and Fire Protection Systems to meet the Seismic and Wind Load Requirements.

AT/FP Requirements: The AT/FP requirements of UFC 4-010-01 shall be applied with an Applicable Level of Protection of "Low" for both buildings. The barracks building is 3 stories in height and therefore must be designed in accordance with requirements for progressive collapse avoidance. In general the building shall be designed such that the vertical load carrying elements of the structure are not exposed to the exterior of the building. Where it is not possible to achieve this, exterior structural load carrying elements shall be designed with redundant mechanisms to transfer load from damaged elements to other structural elements in the building with the intent of preventing the progressive collapse of construction located above damaged areas and reduce potential injuries to building occupants.

Exterior windows and storefront glazing systems shall be designed to withstand blast overpressures related to the relevant explosive weights indicated in Tables B-2 and B-3 of UFC 4-010-01. Additionally, window and door frame to building connections, and supporting building elements shall be designed to withstand these overpressure loads.

6.7. THERMAL PERFORMANCE

No additional Thermal Performance requirements, other than those stated in paragraph three (3) and paragraph five (5), are necessary for this project.

6.8. PLUMBING

No additional Plumbing requirements, other than those stated in paragraph three (3) and paragraph five (5), are necessary for this project.

6.9. SITE ELECTRICAL AND TELECOMMUNICATIONS SYSTEMS

6.9.1 UNDERGROUND DISTRIBUTION SYSTEM

6.9.1.1 DISTRIBUTION

(a) Dominion Virginia Power (DVP) will furnish and install an underground distribution system to provide power to all new facilities constructed by the requirements of this RFP. The distribution system will include but not be limited to cable, manholes, pull boxes, duct bank, switches, conduit and all accessories commonly used in underground distribution. All distribution will be routed underground from the low voltage side of transformers through a duct bank or direct buried conduit raceway system as required. Installation requirements, raceway routing plan and equipment location will be determined by DVP based upon the most efficient means to provide power distribution to the facilities constructed by this RFP.

(b) Contractor will coordinate with DVP to minimize the length of service feeders.

(c) CT cabinets and meters shall be provided by DVP and installed as per DVP requirements. The DB Contractor shall be responsible for coordinating the service location with DVP, installing the DVP provided CT cabinet and providing empty conduit from the metering equipment and extend minimum 5' from building exterior foundation.

6.9.1.2 DISTRIBUTION TRANSFORMERS

(a) Distribution transformer sizes and utilization voltages for each facility will be determined by DVP. Load letters for submission to the electric utility company will be prepared by the DB Contractor. The DB Contractor will coordinate utilization voltages with DVP.

- (b) Transformers will be determined, provided and installed by DVP in accordance with DVP requirements. The DB Contractor to coordinate minimum distance from facility to the pad mount transformer.
- (c) Refer to individual facility loads for possible pole mounted distribution transformers. Pole mounted transformers will reduce ground obstructions. The DB Contractor will coordinate requirements with DVP.
- (d) The low voltage side of the distribution transformers will be connected to the respective facilities via underground 600 volt class distribution system.
- (e) DVP will provide appropriate transformer pad. The DB Contractor will coordinate location of each transformer pad with each facility in project.
- (f) DVP will provide transformers with an identification name to identify the equipment by type or function and specific unit number.

6.9.1.3 DISTRIBUTION TRANSFORMER GROUNDING RING

DVP will provide a buried copper ground ring to which the Distribution Transformers will each be installed and attached.

6.9.1.4 CABLES

- (a) DVP will provide cables for primary circuit from switch to transformers.
- (b) DVP will provide cables from secondary of transformers to a point 5 feet within the new facility as per the requirements of the DVP Information and Requirements for Electric Service "Blue Book". The DVP electrical service requirements (Blue Book) can be obtained at HYPERLINK "http://www.dom.com/customer/pdf/bluebook.pdf" <http://www.dom.com/customer/pdf/bluebook.pdf>.

6.9.1.5 IDENTIFICATION NAMEPLATES

- (a) Major items of electrical equipment and major components will be permanently marked with an identification name to identify the equipment by type or function and specific unit number. Unless otherwise specified, all identification nameplates will be made of laminated plastic in accordance with FS L P 387 with black outer layers and a white core. Edges will be chamfered. Plates will be fastened with black finished round head drive screws or approved no adhesive metal fasteners. When the nameplate is to be installed on an irregularly shaped object, the DB Contractor will devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate will be installed in a conspicuous location. At the option of the DB Contractor, the equipment manufacturer's standard embossed nameplate material with black paint filled letters may be furnished in lieu of laminated plastic. The front of each panelboard will have a nameplate to indicate the phase letter, corresponding color and arrangement of phase conductors.
- (b) The following equipment, as a minimum will be provided with identification nameplates with minimum 1/4 inch high letters:
 - (1) Main Switchboards
 - (2) Equipment Enclosures
 - (3) Panelboards
 - (4) Motor Control Centers
 - (5) Low voltage Distribution Transformers
 - (6) Disconnect Switches

- (7) Motor Disconnects
- (8) Variable Speed Drives
- (9) Remote mounted Circuit Breakers

6.9.2 SITE COMMUNICATION SYSTEM GENERAL REQUIREMENTS AND COORDINATION

(a) The DB Contractor will coordinate all communications design with the Network Enterprise Center (NEC) contact John Beckley at (757) 878-0918 or via email at [HYPERLINK "mailto:john.w.beckley@eustis.army.mil" john.w.beckley@eustis.army.mil](mailto:john.w.beckley@eustis.army.mil). The DB Contractor shall engineer, furnish, install, secure, and test (EFIS&T) the telephone services to include but not be limited to the installation of outside cabling, manholes, conduit, duct bank system, and connections. The DB Contractor shall coordinate with NEC all cable connections for copper at the existing service point tie-in location, as directed by the NEC, or identified herein. Design Analysis will include meeting minutes of coordination effort. All outside plant work will be in accordance with TR No. AMSEL-IE-TI-06001-7 United States Army Information Systems Engineering Command Worldwide Outside Plant Design and Performance Requirements. All design work shall be performed by a Registered Communications Distribution Designer (RCDD) with a minimum of 5 years experience in the application of related telecommunications systems of outside plant and interior systems. Provide evidence to certify designer's qualifications. Existing communication system tie-in location is on existing section of Fort Eustis as follows:

(b) Provide 4" PVC from location of existing pedestals nearest the project site. Install new hand holes to accept one 50 pair copper 24 AWG from this point. Coordinate location of terminations at facility with final location of telecommunications room or telephone backboard. Facility will be provided one 50 pair 24 AWG copper cable as identified below. Terminate copper pair on plywood board in telecommunication room on Building Protected Terminals and 110 connecting blocks in accordance with IAW US Army I3A Technical Guide. Provide 4" PVC concrete encased conduit and cabling in accordance with US Army I3A Technical Guide to facility as identified below from the area manhole as follows:

1. Contractor will install a manhole at every splice point. The installation must maintain proper depth or location of communications cables to avoid heavy vehicle traffic.
 2. Design from these demarcation locations to each facility is the responsibility of the DB Contractor. Coordination of communication system minimum standards as well as final design, connections, routing, existing conditions and construction requirements will be coordinated with the NEC through the Corps of Engineers Field representative.
- (c) Telecommunications cabling for the Barracks building will be run from existing Communications Manhole #7 on Marshall Street to the Telecommunications Room for the Barracks building. The Contractor shall provide 4-4" conduits run underground from Communications Manhole #7 to within the Telecommunications Room: 1-4" conduit shall contain 50 pair copper cable; 1-4" conduit shall contain 4-1" fiber-mesh innerduct for 12 strand fiber optic cable IAW I3A requirements; 2-4" conduits are spare. Conduits with larger capacity will be installed where necessary. All terminations for the cabling both in the manhole and in the Telecommunications Room will be performed by Ft. Eustis NEC personnel.

6.9.3 CONDUITS AND FITTINGS

All exterior power and communications service conduits will be 4 inch or larger PVC. Quad type conduits will be 1-1/4 inch PVC. The DB Contractor may use inner duct configuration with four 1-1/4 inch PVC internal conduits in-lieu of the quad conduit configuration. Conduits installed above grade on poles will be galvanized rigid steel (RGS). Fittings for steel conduit will be steel threaded or compression type. Screw, clamp or other types of fittings are not acceptable.

6.9.4 SITE LIGHTING

Provide an average foot candle (fc) level of 1 fc with a minimum average/minimum uniformity of 6:1 at the building perimeter for a distance of 50 feet minimum on the North, South and East sides of the building. Exterior lighting will

be photocell controlled. Exterior lighting shall utilize pulse start metal halide lamps and energy efficient ballasts. Site lighting shall not produce excess lighting on adjacent properties.

The DB Contractor will design the lighting for the running track and exercise pits for the proposed AIT Facility, in coordination with DVP, and DVP will maintain the system once installed and operational. The design will consist of luminaires, available through DVP, mounted on individual, round, steel lighting poles located around the perimeter of the track to achieve an average level of illumination of 3fc. The 4 exercise pits and 4 climbing bar areas in the infield of the running track will also be illuminated using the same poles and luminaires and to the same lighting levels as the running track. Light poles shall be capable of withstanding a 100mph sustained wind load. Power for the running track and exercise pit lighting shall be provided by DVP and routed underground from a pad mounted transformer adjacent to the lawn Maintenance Building through a meterbase and panelboard located within the Maintenance Building. Manual Running Track and Exercise Pit lighting controls will be located on the exterior of the Maintenance Building adjacent to the service entrance location. All lighting design will be in accordance with UFC.

The DB Contractor will design the lighting for the sidewalks for the proposed AIT Facility, in coordination with DVP, and DVP will maintain the system once installed and operational. The design will consist of luminaires, available through DVP, mounted on individual, steel lighting poles located along the various sidewalks throughout the site. Light poles shall be capable of withstanding a 100mph sustained wind load. Power for sidewalk lighting shall be provided by DVP and routed underground from adjacent buildings. Luminaires shall be controlled using individual, integrated photocells. Lighting levels shall be coordinated with Ft. Eustis personnel and be in accordance with UFC and the Illuminating Engineering Society of North America (IESNA) standards.

6.9.5 GROUNDING

All grounding will be in accordance with the criteria as listed in Paragraph 4. All exposed non-current carrying metallic parts of electrical equipment, metallic raceway systems and neutral conductors of the wiring system will be grounded. All grounding conductors will be insulated. Mechanical (Safety) Ground: A green insulated copper ground wire will be furnished within each circuit conduit. The mechanical ground wire will be sized in accordance with the National Electrical Code. All circuits from equipment will be provided a mechanical ground wire from equipment enclosure to the equipment ground bus in the service electrical panel.

6.9.6 WIRING METHODS

6.9.6.1 All 600 volt secondary service wiring will consist of insulated copper conductors installed in direct buried PVC conduit. Conduits will be buried a minimum of 36 inches below finished grade or 24 inches below pavement in concrete duct bank. Electrical power will be separated a minimum of 12 inches from other system conduits and underground utilities. All buried cable /conduit will be marked with warning tape equipped with metal tracer installed 18 inches immediately above the cable /conduit. Underground connections or splices are prohibited, except in boxes or manholes. Splices will be in a self draining, rodent-resistant box with cover. Provide cover with appropriate labeling. Wire connectors of insulating material or solder-less pressure connectors properly taped will be utilized for all splices. Soldered joints are prohibited.

6.9.6.2 Secondary service conductors will be sized accordingly by Dominion Virginia Power for the facilities services and adjusted for voltage drop as required limiting the voltage drop to not more than 2 percent.

6.9.6.3 Lighting conductors will be sized for the load and adjusted for voltage drop as required to limit voltage drop to not more than 3 percent at the end of the circuit.

6.9.6.4 Power conductor wiring identification will be made by permanently attached markers and by color. Conductor identification will be provided within each enclosure. Each conductor will be identified by plastic-coated printed markers, permanently attached stamped metal foil markers, or by equivalent means. Hand lettering or marking is not acceptable. Marking will include the phase (or neutral), panel identification, and circuit number. The color of the insulation on phases A, B and C respectively (for 3 phase power conductors) or Phases A and B (for single phase power conductors) as follows:

- (a) 208Y/120 Volt, Phase A- Black, Phase B- Red, Phase C- Blue.

(b) 480Y/277 Volt, Phase A - Brown, Phase B-Orange, Phase C-Yellow.

(b) Conductor identification by a particular color will be maintained continuously for the length of the circuit including junction boxes and splices.

6.9.6.5 Specialized Power Requirements: Coordinate specialized equipment electrical connections with the system manufacturer.

6.9.6.6 All power conductors will be installed in conduit.

There are no additional Facility Telecom requirements, other than those stated in this RFP.

6.10. FACILITY ELECTRICAL AND TELECOMMUNICATIONS SYSTEMS

6.10.1. LOADS

The loads for all facilities will be determined by the DB Contractor. A load letter and site plan will be required for submission to DVP so that the distribution system can be designed by DVP.

6.10.2 SWITCHGEAR

The DB Contractor will coordinate the service voltage of each facility based on the calculated load and availability of service from DVP. Switchgear will be located in the electrical rooms of the facilities and will include, but not be limited to, the following components:

(a) Circuit breakers for the distribution panel for the mechanical equipment.

(b) Circuit breakers for the main distribution panel.

(c) Circuit breaker for feeder to all required lighting and appliance panels.

(d) All switchgear power distribution equipment will have metering (Volt Meter-selectable to three phases, Amp meter-selectable to three phases, kWh Meter with peak demand register and pulse generator for connection to Installation's EMCS)

(e) Circuit breaker for feeder to all required TVSS devices at service entrance panels.

(f) Circuit breakers for feeder to all required Step-up/Step-down distribution transformers.

6.10.3 POWER DISTRIBUTION

6.10.3.1 Primary electrical service for the AIT Facility is from the Dominion Virginia Power (DVP) underground distribution system. All exterior electrical design work shall be coordinated with DVP which owns and operates the primary exterior electrical distribution system on Ft Eustis. DVP will be responsible for the design and construction of all exterior primary and secondary work up to the service disconnect provided by the DB Contractor. The Government will engage DVP to perform this work and pay all associated costs, however, the DB Contractor shall carefully adapt scheduling and performing the work under this RFP to fully coordinate with and accommodate work by DVP. A load letter will need to be submitted for each facility.

6.10.3.2 All new service entrance and distribution power panels will have 15 percent spare load capacity. All equipment (transformers, lighting panels, appliance panels, motor control centers, etc.) will have 10 percent spare capacity. Power distribution equipment will have 10 percent spare connection capability with all panels having full bus bars ready for addition of future breakers.

6.10.4 EXTERIOR ELECTRICAL

6.10.4.1 EXTERIOR LIGHTING

(a) Building mounted lighting, site lighting, sign lighting, etc will be provided by the DB Contractor.

(b) Photocell switches will be hermetically sealed cadmium-sulfide or silicon diode type cell rated for utilization voltage, 60 Hz with single-throw contacts designed to fail to the ON position. Switches will turn on at or below 3 fc and off at 4 to 10 fc. A time delay will prevent accidental switching from transient light sources. Provide switch in a high-impact-resistant, non-corroding and non-conductive molded plastic housing.

6.10.4.2 LIGHTNING PROTECTION SYSTEM

The DB Contractor will verify the requirement for a lightning protection system as it applies to structures or open areas referenced in the RFP. The DB Contractor will perform lightning protection assessment in accordance with NFPA and provide the lightning protection system as determined by the assessment. A building lightning protection system will be provided, if required, and will be connected to the building ground grid at each ground rod location. The system will be installed in compliance with US Army Training Doctrine Command, Guide for Lightning Protective Measures for Personnel and NFPA Standards and installed by a certified installer.

6.10.4.3 CATHODIC PROTECTION SYSTEM

Cathodic protection is not required for this project.

6.10.5 INTERIOR ELECTRICAL

6.10.5.1 INTERIOR LIGHTING

Lighting will conform to UFC and Illuminating Engineering Society of North America (IESNA) Standards. Fluorescent lighting shall utilize premium energy efficient electronic ballasts and low mercury lamps. Ballasts shall be electronic instant start type or electronic programmed rapid start type. Exterior wall mounted fluorescent lighting fixtures with emergency battery backup shall be provided at each exit discharge. Provide exterior wall mounted HID metal halide type lighting fixtures for area site lighting around the building exterior, control of fixtures shall be by photocell. Occupancy sensors shall be provided in restrooms and storage room type areas. Emergency battery backup lighting will be provided throughout the facility in accordance with UFC.

The DB Contractor will design the interior lighting for the Maintenance Building. The design will consist of linear fluorescent lighting fixtures mounted throughout the building to achieve lighting levels in accordance with UFC and the IESNA standards.

6.10.5.2 EMERGENCY EGRESS LIGHTING

Emergency egress lighting will provide a minimum of 1 fc for all means of egress as required by UFC and NFPA. Emergency lighting can be integral to the luminaires lighting the space or individual wall mounted units. Connect emergency lighting luminaires or emergency ballasts to the circuit serving the luminaires in the space ahead of local switching. Power to all emergency egress life safety lighting will be supplied by integral battery back-up modules, with a minimum of ninety minutes operation during a power outage. Illumination will be provided by selected fixtures and wired ahead of any local switching. Additional emergency egress lighting will be provided for exterior egress. The fluorescent fixture over the doorway of each vestibule will be un-switched. Exit signage will be LED. LED exit signs will be wired to flash during fire alarm. Exit signage will be located at all exits and paths of egress as required by UFC and NFPA. Design will include electronic IES file calculations in all critical areas.

6.10.5.3 SWITCHING

(a) Switching for all areas will be wall mounted switches located at each entrance to each area or room. Wall switches will be rated 120-277V, 20A.

(b) Occupancy sensors will be utilized as follows:

1. Restrooms, Day Rooms, Laundry Rooms and one person offices will have multi-technology occupancy sensors to control lighting. Sensors will be adjustable from a range of 30 seconds to 30 minutes. Sensors will be set for a 10 minute time delay at which time lights for normal illumination will be shut-off.
2. Where multiple sensors exist, the approach of "daisy chaining" the sensors to operate as one will be used. If any sensor senses occupancy, then the switched "ON" lights will remain on. The switches and the occupancy

sensors will need to be "ON" for the lights to illuminate. All occupancy sensors will have a maintenance bypass built-in or added in parallel in case of device failure. The corridor lights will be automatically controlled by motion sensors in the corridor.

- (c) Switches located exterior to a facility for all exterior fixtures shall be rated and listed for exterior use.
- (d) Classroom lighting shall incorporate multiple switching to allow for control of individual rows of luminaires.

6.10.5.4. RECEPTACLES

- (a) Receptacles shall be grounding type and rating as required. Receptacles shall be side wiring type with two screws per terminal.
- (b) Provide duplex convenience receptacles located throughout the building so that any point in all floor areas is within approximately 24 feet of a duplex receptacle. GFCI receptacles shall be provided in all restrooms, outdoors, whenever located within 6' of a sink, and where required by the National Electrical Code.
- (c) A weatherproof, GFCI receptacle will be added to the covered assembly area adjacent to the Barracks building in a convenient location.
- (d) Coordinate specialized equipment electrical connections with system manufacturer.

6.10.5.5. PANELBOARDS/LOAD CENTERS

Panelboards shall be the bolt-on circuit breaker type and shall be U.L. listed and labeled. Panelboards shall be fully rated; series rated panelboards are not acceptable. Load centers shall be the plug-on circuit breaker type and shall be U.L. listed and labeled. Load centers shall be fully rated; series rated load centers are not acceptable. Manufactures shall be G.E., Square D, Siemens, Cutler-Hammer, or approved equal. Provide 10% spare capacity.

6.10.5.6. DISCONNECT SWITCHES

Disconnect switches shall be externally operated quick-make, quick-break fused or non-fused heavy duty type. Manufactures shall be G.E., Square D, Siemens, Cutler-Hammer, or approved equal. Provide 10% spare capacity.

6.10.5.7. DRY-TYPE TRANSFORMERS

Transformers shall be general purpose type and have a 150 degree C temperature rise. Provide a transformer suitable for indoor use and in a NEMA 1 enclosure. Manufactures shall be G.E., Square D, Siemens, Cutler-Hammer, or approved equal. Provide 10% spare capacity.

6.10.5.8. WIRING

Feeder and branch circuit wiring shall be individual insulated copper conductors installed in conduit. Metallic armored cables or nonmetallic sheathed cables shall not be used. Feeder and branch circuit wiring shall be in accordance with the National Electrical Code. Minimum wire size shall be #12 AWG and shall have 600 volt insulation unless otherwise noted. Solid copper shall be used for #10 AWG and #12 AWG sizes, conductors larger than #10 shall be stranded. Service entrance cable shall be type USE. Conductors shall be color coded. Feeder conductors will be sized to limit voltage drops to 2 percent. Branch circuit conductors will be sized to limit voltage drop to 3 percent from each branch circuit panelboard or load center to the center of its load. Sharing of neutral conductors is not allowed. Provide 10% spare capacity.

6.10.5.9 FIRE ALARM/MASS NOTIFICATION SYSTEM

Provide a new fire alarm system for the building in accordance with UFC and NFPA. The fire alarm and detection system shall be addressable and shall communicate with the base wide fire alarm system via a BTXM 4 Monaco wireless transmitter. Provide a Mass Notification System (MNS) with the appropriate speakers, equipment, and accessories to deliver voice messages to the building occupants', facility- wide, and be compatible with the base-wide MNS. The MNS control equipment shall be located in the OPS SGT office on the first floor. The MNS shall be in accordance with the UFC.

6.10.5.10 INTRUSION DETECTION SYSTEM

The IDS shall include door alarms and panic door locks on all doors leading to sleeping areas for all male and female soldiers. The alarm will sound at the charge of quarters (CQ) location on the first floor. Alarms will be activated any time any soldier is sleeping while in quarters. The building CDR/1SG shall have the capability to turn alarms on and off as different genders occupy each floor. Additional requirements for the IDS can be found in U.S. Army TRADOC Regulation 350-6. The DB Contractor will provide all empty boxes, conduit and cabling to each door that will require a door alarm and panic door lock. IDS alarm notification equipment will be located at the CQ location on the first floor of the building.

6.10.5.11 DIGITAL VIDEO MONITORING SYSTEM

Provide all empty boxes, conduit and cabling for a digital video monitoring system to monitor and record events in common areas only with digital video equipment. Common areas include corridors, lobbies, stairwells, laundry rooms, day rooms, computer learning rooms, multipurpose space rooms, vaults, secure storage rooms, scrub rooms and weapons cleaning rooms. No cameras will be placed in any living or latrine areas. Additional requirements for the digital video monitoring system can be found in U.S. Army TRADOC Regulation 350-6. The DB Contractor will provide all empty boxes, conduit and cabling to each location that will require a digital video camera. Digital video monitoring system equipment will be located at the CQ location on the first floor of the building.

6.10.5.11 SECRET INTERNET PROTOCOL ROUTER NETWORK (SIPRNET)

No SIPRNET service is required for this building.

6.10.5.12 FACILITY TELECOMMUNICATIONS

1. Communication requirements within the facilities, the DB Contractor will provide telephone connectivity. A standard outlet density of one outlet per 80 square feet will be provided for administrative areas. Consistency will be maintained throughout the installation.
2. Contractor will coordinate with NEC of Fort Eustis to support the LAN switches supporting the 10/100MB LAN being provided and installed by NEC.
3. All Communications backboards and termination equipment will be provided by the DB Contractor.
Telecommunications Room: Room will be designed with adequate conduit or openings through beams and other obstructions into the accessible ceiling space. The telecommunications room contains wiring terminations and communications equipment to serve a building. This equipment will include wiring termination panels, telephone systems, concentrators/hubs that connect communication lines, routers that connect users on different networks, and equipment racks.
4. Voice-only communications will terminate at a plywood back board, 110 type block after the protected entrance terminal. Another 110 block adjacent to the incoming block will be used for terminating building wiring. Cross connect wiring between blocks will be by others and authorized by NEC to meet US Army I3A Technical Guide requirements.

There are no additional Facility Telecom requirements, other than those stated in this RFP.

6.11. HEATING, VENTILATING, AND AIR CONDITIONING

Information included in Paragraph 6 supersedes Paragraph 5 where conflict occurs between the two paragraphs.

6.11.1 If self-contained heat pumps are selected as the HVAC system, then they shall be equipped with emergency electric heat sized to meet the capacity of the entire facility. Refrigerants used must be non-CFC.

6.11.2 HVAC equipment shall automatically start after a power outage.

6.11.3 Ventilation systems shall operate when the building is occupied. Ventilation systems for unoccupied spaces shall operate as necessary, according to building codes and standards.

6.11.4 Ventilation for acceptable indoor air quality shall be in accordance with ASHRAE 62.1. Ventilation is required for occupied spaces such as classrooms and offices and is based on the expected occupant load.

6.11.5 Shower compartments and restrooms shall have an exhaust air system, which will run continuously when occupied.

6.11.6 The DDC control system shall be a fully compliant ANSI/ASHRAE Standard 135 system. Current control vendor at Ft. Eustis is Johnson Controls. Appendix EE shall be used for guidance in the area of generation of drawings, logic diagrams, control sequences, symbols, legends, etc. The building level DDC control system shall be fully integrated with the base wide Ft. Eustis UMCS system located in building 6220. The current base wide UMCS shall fully control and monitor any new DDC control installed. Integration of new DDC equipment shall allow the current base wide UMCS system to perform supervisory monitoring and control functions including but not limited to scheduling, alarm handling, trending, downloading memory to field devices, tree navigation, parameter change of properties, set point adjustments, configuration of operators, execution of global command, report generating plus electrical peak demand limiting and anti-terrorist emergency shutdown in accordance with Military Criteria. All communications between the current base wide UMCS and the new building level DDC networks shall be via ANSI/ASHRAE Standard 135 protocol over the Fort Eustis IP network. The contractor shall extend the current UMCS graphical interactive interface and provide graphical representation for each control system. Graphical interfaces shall include color floor plans with heating and cooling zones, display of controlled components, and read-write control points associated with zones and control components. Appendix FF is provided for the contractor's use in development of a DDC controls specification.

6.11.7 The controls Contractor shall submit final as-built shop drawings in a hard copy and on CD-ROM in AutoCAD format delivered to DPW Fort Eustis office at building 6205.

6.11.8 For common exhaust system serving dryers, system shall be sized with no diversity, minimum 200 CFM of exhaust at 0.0 inches of water per dryer of backpressure. Electrical distribution serving dryers shall be shut tripped in the event that common exhaust system become inoperable. Exhaust system shall employ variable flow strategy to maximize energy savings.

Integrate the control system to the installation's existing UMCS. The existing UMCS is located in building 6220.

Provide M&C Software with a license for no less than 1 clients

Provide M&C Software with a license for no less than 1 points.

6.12. ENERGY CONSERVATION

6.12.1. General

Federal agencies are required by the Energy Policy Act of 2005 (P.L. 109-58), Executive Order 13423, Energy Independence and Security Act of 2007, and Federal Acquisition Regulation (FAR) Section 23.203 to incorporate the performance criteria used for ENERGY STAR®-qualified and FEMP-designated products into procurement contracts for energy consuming products and systems. Criteria for ENERGY STAR Qualified products are attached or can be viewed at: **HYPERLINK**

"http://www.energystar.gov/index.cfm?fuseaction=find_a_product"http://www.energystar.gov/index.cfm?fuseaction=find_a_product.

Provide energy conservation in accordance with Paragraphs 4 (Applicable Criteria), 5 (General Technical Requirements), and 6 (Project Specific Requirements). In addition see Paragraphs 5.9 and 6.15.

6.12.1.1 Air Barrier Testing: Contractor shall use Appendix GG as a supplement and additional clarification to the requirements of paragraph 5.5.2 Building Envelope Sealing Requirements. Appendix II is provided for the contractor's use in development of a specification of air barrier, testing and quality assurance.

6.12.1.2 Appendix HH is provided for use by the contractor for development of a specification for commissioning of all energy related building systems and components.

6.12.2. Inclusion of Renewable Energy Features. The following renewable energy features have been determined lifecycle cost effective, are included in the project budget and shall be provided:

No additional Renewable Energy Features, other than those stated in paragraph three (3) and paragraph five (5), are necessary for this project.

6.13. FIRE PROTECTION

Fire Alarm

Design of fire protection system, including location of fire alarm control and annunciation panels shall be coordinated with the Fire Chief of Fort Eustis.

- (a) All fire protection and life safety features for the facilities will be in accordance with UFC 3-600-01.
- (b) Provide a mass notification system complying with UFC 4-021-01. The Fort Eustis Fire Department requirement for the system is to have a fully addressable panel with a Monaco BTXM 4 transmitter with eight zones that transmit to the Fire Department Communications Center in Building 648.
- (c) Fire Alarm and Detection System: Required fire alarm and detection systems shall be the addressable type. All initiation devices shall have unique addresses. Provide a graphic annunciator panel at the main building entrance.
- (d) Preliminary Fire Flow Test Data is provided in Appendix D.
- (e) Each fire department connection shall be a 5 inch Storz connection.
- (f) The Contractor shall provide the following infrastructure and equipment to support Government Furnished Government Automatic External Defibrillators. The Contractor shall design and place AED cabinets throughout the facility so that the AED user does not travel more than 300 feet to reach the device. At a minimum, one AED cabinet shall be located on each level of the building. POC is Assistant Fire Chief Ken Pence, (804) 765-3698.
 - 1) A 17 ½" H x 17 ½" W x 7 ¼" deep recessed AED Cabinet.
 - 2) Each AED cabinet shall be furnished with a tamper switch to send a supervisory signal to the fire department through the fire alarm panel alerting them when the cabinet door is opened.
 - 3) An 8 ½" x 11" AED PLUS wall sign.
 - 4) Necessary electrical and fire alarm connectivity.

6.14. SUSTAINABLE DESIGN

6.14.1. LEED Rating Tool Version. This project shall be executed using LEED-NC Version 3.

6.14.2. The minimum requirement for this project is to achieve LEED Silver level. Each non-exempt facility (building plus sitework) must achieve this level. In addition to any facilities indicated as exempt in paragraph 3, the

following facilities are exempt from the minimum LEED achievement requirement: There are no buildings exempt from the minimum Silver requirement..

6.14.3. Credit Validation: LEED registration, compiling of documentation at LEED OnLine and use of the LEED Letter Templates is required. Registration and payment of registration fees will be by the Contractor. Administration/team management of the online project will be by the Contractor. Validation of credits will be accomplished by the Government. LEED certification of the project by the Contractor is not required. The Government may choose to seek LEED certification of the project, in which case the Government will pay certification fees and coordinate with the GBCI and the Contractor will furnish audit data as requested at no additional cost.

6.14.4. Commissioning: See Appendix M for Owner's Project Requirements document(s).

6.14.5. LEED Credits Coordination. The following information is provided relative to Sustainable Sites and other credits.

SS Credit 1 Site Selection:

Project site IS NOT considered prime farmland.

Project site is five feet or more above 100-year flood elevation.

Project site contains no habitat for threatened or endangered species.

No portion of project site lies within 100 feet of any water, wetlands or areas of special concern.

Project site WAS NOT previously used as public parkland.

SS Credit 2 Development Density & Community Connectivity.

Project site DOES NOT meets the criteria for this credit.

SS Credit 3 Brownfield Redevelopment.

Project site DOES NOT meets the criteria for this credit.

SS Credit 4.1 Public Transportation Access.

Project site DOES NOT meets the criteria for this credit.

EA Credit 6 Green Power.

35% of the project's electricity WILL NOT will be provided through an Installation renewable energy contract. Do not purchase Renewable Energy Credits (REC's) to earn this credit.

MR Credit 2 Construction Waste Management.

The Installation does not have an on-post recycling facility available for Contractor's use.

Regional Priority Credits (Version 3 only)

The project zip code is 23604.

6.14.6. LEED Credit Preferences, Guidance and Resources. See Appendix L LEED Project Credit Guidance for supplemental information relating to individual credits.

6.14.7. Not Used

6.14.8. Additional Information

The minimum facility energy efficiency shall be 40% beyond ASHRAE 90.1.

6.14.9 See Appendix M for Owner's Project Requirements document(s). Refer to Appendix II and KK for Sample Commissioning Plan and Basis of Design Document for use in editing to meet the requirements of LEED fundamental commissioning requirements.

6.15. ENVIRONMENTAL

No additional Environmental requirements, other than those stated in paragraph three (3) and paragraph five (5), are necessary for this project.

6.16. PERMITS

The contractor is responsible for the permits stated throughout this document.

6.17. DEMOLITION

Privatized utilities will be removing the existing water, sewer, natural gas, and electrical lines. Contractor shall coordinate construction activities with the privatized utilities as necessary. The existing storm-water improvements shall be demolished only as indicated in the attached documents.

6.18. ADDITIONAL FACILITIES

No additional Facility requirements, other than those stated in paragraph three (3) and paragraph five (5), are necessary for this project.

6.19 OTHER PROJECT REQUIREMENTS

6.19.1 PROJECT WORK REQUIREMENTS AND RESTRICTION

6.19.1.1 Hours of Work

The normal work hours for construction shall be from 0730 to 1600, Monday through Friday of each week. Any request to change these hours shall be made in writing to the Contracting Officer at least two calendar days prior to the desired day on which the change is to go into effect. The changed hours shall not go into effect until written permission has been received from the Contracting Officer.

6.19.1.2 Gate Times

Main Gate: 24 hours a day, seven days a week

Fort Eustis Gate passes are obtained by submitting full name, full social security number, sex, race and date of birth on a "company letterhead stationary" along with a general statement explaining what the person/s will be doing on Fort Eustis and for how long, to the MP station at Building 648 or fax to 878-5481. This information can be given to the COE office who in turn forwards to the MPs. The information is run through vehicle registration at Building 2 where the passes will be picked up.

6.19.1.3 Cellular Phone Use

Cellular phone use is prohibited within the construction site, except by superintendents and job foremen. Cellular phone use while driving and/or operating construction equipment is prohibited.

6.19.1.4 Antiterrorism and Force Protection

Electronic Intrusion Detection System (IDS): Any IDS installed will be compatible with the current Fort Eustis base-wide system, to include the current base-wide operating platform and remote monitoring work stations and will meet all Fort Eustis and US Army security requirements. The IDS shall include, but no limited to, passive infrared

detection, triple balanced biased magnetic switches, central on-site IDS controller which monitors, interrogates, supervises, annunciates, identifies unauthorized intrusion, electronically notifies the operating platform by use of "dry copper telephone lines" (no cellular communication) in order for the base security response to events. Contractor will coordinate all IDS issues with the user and the Physical Security Office, Ft Eustis.

6.19.2 PROJECT SCHEDULE

Information contained within this paragraph shall supplement Section 01 32 01.00 10, providing requirements specific to Norfolk District USACE.

6.19.2.1 GENERAL REQUIREMENTS

Pursuant to the Contract Clause, SCHEDULE FOR CONSTRUCTION CONTRACTS, a Project Schedule as described below shall be prepared. The NAS Project Schedule shall be a composite schedule including the design and construction activities. The scheduling of construction design and construction shall be the responsibility of the Contractor. Contractor management personnel shall actively participate in its development. Subcontractors and suppliers Designers, Subcontractors and suppliers working on the project shall also contribute in developing and maintaining an accurate Project Schedule. The approved Project Schedule shall be used

To measure the progress of the work, to aid in evaluating time extensions, and to provide the basis of all progress payments. The Government will use the NAS Project Schedule to evaluate the contractor's progress for timely completion, plan for Quality Assurance verification of the work and evaluate the effects of a proposed modification on the contract duration (critical path activities)

6.19.2.2 QUALIFICATIONS- CONTRACTOR SCHEDULING REPRESENTATIVE

The Contractor shall designate, a scheduling representative, the individual tasked with the responsibility for preparation-updating-revision of the NAS schedule who shall be responsible for the preparation and submittal of the entire NAS project schedule including all items specified below and revisions to the schedule or supplemental completion schedules, as applicable or directed by the Contracting Officer. The scheduling representative shall be approved by the Contracting Officer based on a resume indicating as a minimum, formal training from software vendor or 5 years experience in working with NAS schedules.

6.19.2.3 BASIS FOR PAYMENT

The schedule shall be the basis for measuring Contractor progress. Lack of an approved schedule or scheduling personnel will result in an inability of the Contracting Officer to evaluate Contractor's progress for the purposes of payment. Failure of the Contractor to provide all information, as specified below, shall result in the disapproval of the entire Project Schedule submission and the inability of the Contracting Officer to evaluate Contractor progress for payment purposes. In the case where Project Schedule revisions have been directed by the Contracting Officer and those revisions have not been included in the Project Schedule, the Contracting Officer may hold retainage up to the maximum allowed by contract, each payment period, until revisions to the Project Schedule have been made.

6.19.2.4 PROJECT SCHEDULE

The contractor shall prepare the NAS schedule using a computer software system. The system utilized by the Contractor shall be capable of satisfying all requirements of this specification and ER 1-1-11. Manual methods used to produce any required information shall require prior approval by the Contracting Officer. The Contracting Officer intends to use PRIMAVERA P3. Should the contractor utilize software that is different than that utilized by the Contracting Officer, based on the software utilized by the contractor for the preparation of the NAS schedule, the

Contractor shall provide a copy of the software and a license to the Administrative Contracting Officer at the Government field office. The Contractor shall submit a copy of the user's manual outlining the selected CPM computer program's mathematical analysis capabilities, details, functions and operation. The Contractor shall provide to the Government a complete input listing for the selected software.

a) The Critical Path Method (CPM) of network calculation shall be used to generate the Project Schedule. The Contractor shall provide the Project Schedule in the Precedence Diagram Method (PDM).

b) The Project Schedule shall include an appropriate level of detail. Failure to develop or update the Project Schedule or provide data to the Contracting Officer at the appropriate level of detail, as specified by the Contracting Officer, shall result in the disapproval of the schedule. The Contracting Officer will use, but is not limited to, the following conditions to determine the appropriate level of detail to be used in the Project Schedule:

1 Cost and Resource Loading

a. Cost Loading Activities: Costs for incremental design preparation will be assigned to the respective design phase submittal milestone(s). Equipment costs will be assigned to their respective Procurement Activities (i.e., the delivery milestone activity). Costs for installation of the material/equipment (labor, construction equipment, and temporary materials) will be assigned to their respective Construction Activities. The value of inspection/testing activities will not be less than 10 percent of the total costs for Procurement and Construction Activities. Evenly disperse overhead and profit to each activity over the duration of the project. The total of all cost loaded activities; including costs for material and equipment delivered for installation on the project, and labor and construction equipment loaded construction activities, shall total to 100 percent of the value of the contract.

b. Quantities and Units of Measure: Each cost loaded activity will have a detailed breakdown of the contract price, giving quantities for each of the various kinds of work, unit prices, etc.

c. Labor Resource Loading: As part of the Baseline Schedule development each construction activity shall have an estimate of the number of workers per day by trade, hours per day by trade and total expected hours used by trade during the execution of the activity. If no workers are required for an activity, then the activity shall be identified as using zero workers per day. Actual labor resource expended on an activity will be recorded in the monthly updated schedules and will coincide with entries made in the Daily Reports.

d. Equipment Resource loading: As part of the Baseline Schedule development each construction activity shall have an estimate of the equipment used per day, number of units per day and total expected hours for each piece of equipment used during the duration of the activity. Include a description of the major items of construction equipment planned for each construction activity on the project. The description shall include the year, make, model, and capacity. If no equipment is required for an activity, then the activity shall be identified as using zero equipment per day. Actual equipment resource expended on an activity will be recorded in the monthly updated schedules and will coincide with entries made in the Daily Reports.

2 Activity Durations - Contractor submissions shall follow the direction of the Contracting Officer regarding reasonable activity durations. Reasonable durations are those that allow the progress of activities to be accurately determined between payment periods (usually less than 2 percent of all non-procurement activities' Original Durations are greater than 20 days). Durations shall be in work days.

3 Design and Permit Activities - Design and permitting activities, including necessary conferences and follow-up actions and design package submission dates, shall be integrated into the schedule.

4 Procurement Activities - Tasks related to the procurement of long lead materials or equipment shall be included as separate activities in the project schedule. Long lead materials and equipment are those materials that have a procurement cycle of over 90 days. Examples of procurement process activities include, but are not limited to: submittals, approvals, procurement, fabrication, and delivery.

5 Critical Activities - The following activities shall be listed as separate line activities on the Contractor's project schedule:

- a. Submission and approval of mechanical/electrical layout drawings.
- b. Submission and approval of O & M manuals.
- c. Submission and approval of as-built drawings.
- d. Submission and approval of 1354 data and installed equipment lists.
- e. Submission and approval of testing and air balance (TAB).

- f. Submission of TAB specialist design review report.
- g. Submission and approval of fire protection specialist.
- h. Submission and approval of testing and balancing of HVAC plus commissioning plans and data.
- i. Air and water balance dates.
- j. HVAC commissioning dates.
- k. Controls testing plan.
- l. Controls testing.
- m. Performance Verification testing.
- n. Other systems testing, if required.
- o. Pre-final inspection.
- p. Correction of punch list from pre-final inspection.
- q. Final inspection.

6 Government Activities - Government and other agency activities that could impact progress shall be included in the schedule. These activities include, but are not limited to: Government approvals, Government review and verification that design submittals are in accordance with the RFP, inspections, utility tie-in, Government Furnished Equipment (GFE) and Notice to Proceed (NTP) for phasing requirements, environmental permit approvals by State regulators, inspections, Government approval of shop drawings activities should be shown with the duration at least the minimum allowed by the contract. The contractor's failure to provide reasonable durations in its schedule for Government activities does not establish or change the Government's review or approval path periods and the durations established for Government's activities are subject to approval by the Contracting Officer.

- a. Work activities to be included on the critical path
- ⌚ CQC (all) mechanical systems test (indicate the specific system)
- ⌚ CQC (all) electrical system tests (indicate the specific system)
- ⌚ Government QA (all) mechanical system acceptance/operational test (indicate specific system)
- ⌚ Government QA (all) electrical system acceptance /operational test (indicate specific system)
- ⌚ CQC completion inspection of the entire project
- ⌚ Contractor works off CQC punch list
- ⌚ Pre-final inspection performed when the facility is completed such that it can be used for its intended function (as determined by the Contracting Officer)
- ⌚ Contractor works off pre-final punch list
- ⌚ Final/acceptance inspection of the entire project
- ⌚ Contractor works off final punch list.
- ⌚ Contractor shall allow 30 calendar days total duration prior to current contract completion date for the above stated activities. (See Specification Section 01 45 04.00 50 CONTRACTOR QUALITY CONTROL).

b. Contracts with multiple buildings/facilities - The contractor shall prepare a separate detailed NAS schedule for each building/facility indicating its critical path for specified interim completion dates or critical milestone date. The master NAS schedule shall indicate the interface/lag/link between buildings/facilities to maximize/level the labor and other resources. The master schedule critical path must be indicated through the various buildings/facilities and total duration equal to the contract duration.

7 Responsibility - All activities shall be identified in the project schedule by the party responsible to perform the work. Responsibility includes, but is not limited to, the subcontracting firm, contractor work force, or government agency performing a given task. Activities shall not belong to more than one responsible party. The responsible party for each activity shall be identified by the Responsibility Code.

8 Work Areas - All activities shall be identified in the project schedule by the work area in which the activity occurs. Activities shall not be allowed to cover more than one work area. The work area of each activity shall be identified by the Work Area Code.

9 Modification or Claim Number - Any activity that is added or changed by contract modification or used to justify claimed time shall be identified by a mod or claim code that changed the activity. Activities shall not belong to more than one modification or claim item. The modification or claim number of each activity shall be identified by the Mod or Claim Number. Whenever possible, changes shall be added to the schedule by adding new activities. Existing activities shall not normally be changed to reflect modifications.

10 Bid Item - All activities shall be identified in the project schedule by the Bid Item to which the activity belongs. An activity shall not contain work in more than one bid item. The bid item for each appropriate activity shall be identified by the Bid Item Code.

11 Phase of Work - All activities shall be identified in the project schedule by the phases of work in which the activity occurs. Activities shall not contain work in more than one phase of work. The project phase of each activity shall be by the unique Phase of Work Code.

12 Category of Work - All Activities shall be identified in the project schedule according to the category of work which best describes the activity. Category of work refers, but is not limited, to the procurement chain of activities including such items as submittals designs, design package submissions design reviews, review conferences, permits, submittals, approvals, procurement, fabrication, delivery, installation, start-up, and testing. The category of work for each activity shall be identified by the Category of Work Code.

13 Feature of Work - All activities shall be identified in the project schedule according to the feature of work to which the activity belongs. Feature of work refers, but is not limited to, a work breakdown structure for the project. The feature of work for each activity shall be identified by the Feature of Work Code.

c) Scheduled Project Completion - The schedule duration shall extend from NTP to the official contract completion date as awarded (unless approved by Contracting Officer-for early completion).

1 Project Start Date - The schedule shall start no earlier than the date on which the NTP was acknowledged. The Contractor shall include as the first activity in the project schedule an activity called "Start Project". The "Start Project" activity shall have an "ES" constraint date equal to the date that the NTP was acknowledged, and a zero day duration.

2 Constraint of Last Activity - Completion of the last activity in the schedule shall be constrained by the contract completion date. Calculation on project updates shall be such that if the early finish of the last activity falls after the contract completion date, then the float calculation shall reflect a negative float on the critical path. The Contractor shall include as the last activity in the project schedule an activity called "End Project". The "End Project" activity shall have an "LF" constraint date equal to the completion date for the project, and a zero day duration.

3 Early Project Completion - In the event the project schedule shows completion of the project prior to the contract completion date, the Contractor shall identify those activities that have been accelerated and/or those activities that are scheduled in parallel to support the Contractor's "early" completion. Contractor shall specifically address each of the activities noted in the narrative report at every project schedule update period to assist the Contracting Officer in evaluating the Contractor's ability to actually complete prior to the contract period. The Contractor shall include an activity named "contingency" with no cost and a duration equal to the number of

calendar days from the date all the contract work is planned to be completed, to the official contract completion date as awarded.

d) Interim Completion Dates

Contractually specified interim completion dates shall also be constrained to show negative float if the early finish date of the last activity in that phase falls after the interim completion date.

1 Design phase - The contractor shall include the following design phase activities in the composite design and construction NAS Project schedule.

- a. Pre-work conference within 5 days after NTP
- b. Design Charrette (Preliminary Design) within 7 days after NTP
- c. Submittal of preliminary design (60%)
- d. Design review conference of Preliminary design Submittal of Final design (95%)
- e. Design review conference of Final design
- f. Submittal of Corrected Final design (100%)
- g. Design review conference of Corrected Final design
- h. Design Complete--- {The contracting officer shall advise the contractor in writing when the final design documents are approved for construction}
- i. The duration of each of these activities must be the duration as included in the contract award.

2 Design Network Analysis Schedule

Submit the Design Network Analysis Schedule defining the planned operations during the design phase(s) of the contract. The general (summarized) approach for the construction phase(s) of the project shall also be indicated. When the project is being Fast-Tracked, the Design Network Analysis Schedule shall include all fast-tracked design phases, including the required or proposed design submittals within each phase that will occur during the duration of the project. In accordance with paragraph entitled "Monthly Network Analysis Updates" the design network may be used for requesting progress payments for a period not to exceed the design phase(s) of the contract. Submittal and acceptance of the Design Network Analysis Schedule is condition precedent to the processing of the Contractor's pay requests on this schedule. The activities and relationships of the design schedule shall coincide and mesh with the activities of the Baseline NAS project Schedule. As part of this submittal, provide the Project Name format (and Project Group Name if used) that will be used by the Contractor to identify initial schedule submittals, updates, fragments, changes, etc.

3 Start Phase - The Contractor shall include as the first activity for a project phase an activity called "Start Phase X" where "X" refers to the phase of work. The "Start Phase X" activity shall have an "ES" constraint date equal to the date on which the NTP was acknowledged, and a zero day duration.

4 End Phase - The Contractor shall include as the last activity in a project phase an activity called "End Phase X" where "X" refers to the phase of work. The "End Phase X" activity shall have an "LF" constraint date equal to the completion date for the project, and a zero day duration.

5 Phase X - The Contractor shall include a hammock type activity for each project phase called "Phase X" where "X" refers to the phase of work. The "Phase X" activity shall be logically tied to the earliest and latest activities in the phase.

e) Default Progress Data Disallowed

Actual Start and Finish dates shall not be automatically updated by default mechanisms that may be included in CPM scheduling software systems. Actual Start and Finish dates on the CPM schedule shall match those dates provided from Contractor Quality Control Reports. Failure of the Contractor to document the Actual Start and Finish dates on the Daily Quality Control report for every in-progress or completed activity, and failure to ensure that the data contained on the Daily Quality Control reports is the sole basis for schedule updating shall result in the disapproval of the Contractor's schedule and the inability of the Contracting Officer to evaluate Contractor progress for payment purposes. Updating of the percent complete and the remaining duration of any activity shall be independent functions. Program features which calculate one of these parameters from the other shall be disabled.

f) Out-of-Sequence Progress

Activities that have posted progress without all preceding logic being satisfied (Out-of-Sequence Progress) will be allowed only on a case-by-case approval of the Contracting Officer. The Contractor shall propose logic corrections to eliminate all out of sequence progress or justify not changing the sequencing for approval prior to submitting an updated project schedule.

g) Negative Lags

Lag durations contained in the project schedule shall not have a negative value.

6.19.2.5 PROJECT SCHEDULE SUBMISSIONS

The Contractor shall provide the submissions as described below. The data for each submission is as follows: The contractor shall provide a bar chart schedule for the first 30 calendar days of the contract at the Pre-construction conference.

a) Preliminary NAS Project Schedule Submission

The Preliminary NAS Project Schedule, defining the Contractor's planned operations for the first {90} calendar days shall be submitted for approval within 21 days after NTP. The approved preliminary schedule shall be used for payment purposes not to exceed {90} calendar days after NTP. The preliminary schedule shall be detailed for the first {90} days and depict the remainder of the project in summary format. The preliminary schedule shall be submitted on data disk or CD (2 copies).

Two hard copies of diagrams in color.

Three hard copies of all sorts / report ----earning curve----manpower plot

b) Initial NAS Project Schedule Submission

The Initial NAS Project Schedule shall be submitted for approval within 60 calendar days after NTP is acknowledged. The schedule shall include detailed activities for the entire project with a reasonable sequence of activities, and shall be at a reasonable level of detail as approved by the Contracting Officer.

The Initial schedule shall be submitted on data disk or CD (2 copies).

Two hard copies of diagrams in color.

Three hard copies of all sorts / report ----earning curve----manpower plot

c) Monthly Network Analysis Updates (Entire NAS Project Schedule)

The Contractor shall submit monthly schedule updates to the Contracting Officer for approval. Monthly updates shall continue until the contract is accepted by the Contracting Officer. These submissions shall enable the Contracting Officer to evaluate the Contractor's monthly progress.

The contractor's invoice may be deemed as an improper invoice, if it fails to provide monthly updates acceptable to Contracting Officer, this may delay progress payment and may result in an interim unsatisfactory performance

rating. The contractor shall include its requests to revise/adjust the NAS schedule for approval, prior to implementing the revisions into the official schedule.

d) Review and Evaluation

After the Government's review(s) of the Design Network Analysis Schedule and Initial Network Analysis Schedule, the Contractor shall meet with the Contracting Officer to discuss the review and evaluation of the NAS submittal. Revisions necessary as a result of this review shall be resubmitted for acceptance within 10 calendar days after the meeting.

1 Acceptance - Review comments made by the Government on the Contractor's schedule(s) will not relieve the Contractor from compliance with requirements of the Contract Documents. The Contractor is responsible for scheduling, sequencing, and prosecuting the Work to comply with the requirements of the Contract Documents. Government acceptance extends only to the activities of the Contractor's schedule that the Government has been assigned responsibility for and agrees it is responsible. The Government will also review for contract imposed schedule constraints and conformance, and cost loading of the CPM activities. Comments offered on other parts of the schedule, which the Contractor is assigned responsibility, are offered as a courtesy and are not conditions of Government acceptance; but are for the general conformance with established industry schedule concepts.

a. When the Design Network Analysis Schedule is submitted and accepted by the Contracting Officer it will be considered the "Baseline Network Analysis Schedule for Design". The Design Network Analysis Schedule shall be updated at least monthly or submitted as part of the design submittals, whichever occurs first. When the Initial NAS Project Schedule is submitted and accepted by the Contracting Officer, it will then be considered the "Baseline Network Analysis Schedule". The Baseline Network Analysis Schedule will then be used by the Contractor for planning, organizing, and directing the work; reporting progress; and requesting payment for work accomplished. The schedule will be updated monthly by the Contractor and submitted monthly with the progress pay request to reflect the current status of the work. Submittal and acceptance of the Baseline Network Analysis Schedule for Design and Baseline Network Analysis Schedule and accurate updated schedules accompanying the pay requests are both conditions precedent to processing pay requests. Only bonds will be paid prior to acceptance of the Baseline Schedule(s).

b. Submittal of the Network, and subsequent schedule updates, will be understood to be the Contractor's representation that the submitted schedule meets all of the requirements of the Contract Documents, accurately reflects the work accomplished, and that Work will be executed in the sequence indicated on the submitted schedule.

2 Baseline Network Analysis Schedule - Once review comments are resolved and the Contracting Officer has accepted the Design Network Analysis Schedule and Construction Network Analysis Schedule, the Contractor shall within 5 calendar days furnish:

a. Two copies of the network diagrams.

b. Two copies of the Cash Flow S-Curve indicating the cash flow based upon both the projected early and late finish dates.

c. Two sets of data disks containing the project schedule shall be provided for the initial submission and every periodic project update. Data shall be submitted on electronic media that is acceptable to the Contracting Officer. A permanent exterior label shall be affixed to each disk submitted. The label shall indicate the type of schedule (Design NAS, Construction NAS, Baseline, Update, Recovery, Change, etc.), full contract number, Project Name used to identify project in scheduling software, contract name & location, data status date, diskette number with total number of diskettes in set, software name and version used to run the schedule, and the name and telephone number of person responsible for the schedule. For major revisions, updates or changes to the network diagrams, once accepted by the Contracting Officer, the Contractor shall submit these same diagrams and reports.

e) Standard Activity Coding Dictionary

The Contractor shall use the activity coding structure defined in the Standard Data Exchange Format (SDEF) in ER 1-1-11, Appendix A. This exact structure is mandatory, even if some fields are not used.

6.19.2.6 SUBMISSION REQUIREMENTS

The following items shall be submitted by the Contractor for the preliminary submission, initial submission, and every periodic project schedule update throughout the life of the project:

a) Data Disks

Two data disks containing the project schedule shall be provided. Data on the disks shall adhere to the SDEF format specified in ER 1-1-11, Appendix A.

1 File Medium - The electronic files will be supplied on compact disc, read-only memory (CD-ROM) unless otherwise approved by the Contracting Officer.

2 Disk Label - A permanent exterior label shall be affixed to each disk submitted. The label shall indicate the type of schedule (Preliminary, Initial, Update, or Change), full contract number, project name, project location, data date, name and telephone number or person responsible for the schedule, and the MS-DOS version used to format the disk.

3 File Name - Each file submitted shall have a name related to the schedule data date, project name, or contract number. The Contractor shall develop a naming convention that will ensure that the names of the files submitted are unique. The Contractor shall submit the file naming convention to the Contracting Officer for approval.

b) Narrative Report

A Narrative Report shall be provided with the preliminary, initial, and each monthly update of the project schedule. This report shall include a description of activities along the most critical paths, a description of current and anticipated problem areas or delaying factors and their impact, and an explanation of corrective actions taken or required to be taken. The narrative report is expected to relay to the Government, the Contractor's thorough analysis of the schedule output and its plans to compensate for any problems, either current or potential, which are revealed through that analysis. If the contractor believes that any Government action or inaction has, or potentially, will impact its progress, it will include the specific notice of the fact in this report. This information should include the activity number of the impacted work, nature and duration of the impact. The narrative report shall address all modifications and weather activities that were input for the progress and their impact on the contract completion and total float.

c) Approved Changes Verification

Only project schedule changes that have been previously approved by the Contracting Officer shall be included in the schedule submission. The Narrative Report shall specifically reference, on an activity by activity basis, all changes made since the previous period and relate each change to documented, approved schedule changes.

d) Schedule Reports

The format for each activity for the schedule reports listed below shall be printed for those activities in progress or completed. The report shall contain:

Activity Numbers

Activity Description

Original Duration

Remaining Duration

Early Start Date

Early Finish Date

Late Start Date

Late Finish Date

Total Float

Actual Start

Actual Finish Dates

1. Milestone Report - The established monthly and special milestones shall be included in this report. The milestones must be established for each significant project features such as: Clearing-grading-demolition, foundation, slab-on-grade, structure-frame, exterior walls-windows, roof-building dry-in, interior walls-mech/elect R/I, above ceiling mech/elect R/I, ceiling, interior wall finish--doors, painting-coverings, floor finish, installation of mech/elect and other equipment-fixtures-casework, plumbing, HVAC system, finish interior mech/elect, testing-commissioning mech/elect systems, onsite utilities, paving-landscaping, prefinal-final inspections-final cleanup and/or other features (as applicable for the project).

The milestones for a building must approximate the following

Milestone work activity % of total duration

NTP 0%

STRUCTURE COMPLETE 36%

ROOF COMPLETE 40%

BUILDING DRY-IN 44%

INTERIOR WALLS COMPLETE 53%

PLUMBING COMPLETE 78%

FLOORING COMPLETE 80%

HVAC DUCTWORK 88%

FINISH MECH/ELECT SYSTEMS COMPLETE 91%

QC TESTING COMPLETE 92%

QA ACCEPTANCE TESTING COMPLETE 93%

CQC INSPECTION OF ENTIRE CONTRACT 95%

PREFINAL INSPECTION 97%

FINAL INSPECTION 99%

CCD 100%

Late Start /Late Finish Report

Late Start -Actual Start/Late Finish-Actual Finish-----total float-duration sort -----sorted by LS in chronological order from data date to contract completion date.

2 Activity Report - A list of all activities sorted according to activity number.

3 Logic Report - A list of Preceding and Succeeding activities for every activity in ascending order by activity number. Preceding and succeeding activities shall include all information listed above in paragraph Schedule Reports. A blank line shall be left between each activity grouping.

4 Total Float Report - A list of all incomplete activities sorted in ascending order of total float. Activities which have the same amount of total float shall be listed in ascending order of Early Start Dates. Completed activities shall not be shown on this report.

5 Earnings Report - A compilation of the Contractor's Total Earnings on the project from the NTP until the most recent Monthly Progress Meeting. This report shall reflect the Earnings of specific activities based on the agreements made in the field and approved between the Contractor and Contracting Officer at the most recent Monthly Progress Meeting. Provided that the Contractor has provided a complete schedule update, this report shall serve as the basis of determining Contractor Payment. Activities shall be grouped by bid item and sorted by activity numbers. This report shall: sum all activities in a bid item and provide a bid item percent; and complete and sum all bid items to provide a total project percent complete. The printed report shall contain, for each activity: the Activity Number, Activity Description, Original Budgeted Amount, Total Quantity, Quantity to Date, Percent Complete (based on cost), and Earnings to Date.

e) Network Diagram

One hard copy of the network diagram shall be required on the preliminary schedule, initial schedule submission, and updated on each monthly schedule submissions. Monthly updates must indicate actual progress as of the data date. The network diagram shall depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished.

Network diagrams shall show the order and interdependence of project activities and the sequence in which the work is to be accomplished, as planned by the Contractor. The network diagramming procedure which will be used will show how the start of a given activity is dependent on the completion of preceding activities, and how its completion restricts the start of following activities.

Activity Duration: The activity duration shall be indicated in "work" days, and revise the assigned calendar.

The contractor may request to change the work days from 5 days/week to 6 or 7 days/week should this action become necessary to regain the schedule due to problems unrelated to the Government actions.

Contractor submissions shall include reasonable activity durations as determined by the contractor and subcontractors. The durations are to be determined by the contractor using the planned crew size/composition.

The network diagram shall be required on the initial schedule submission and on monthly schedule update submissions. The network diagram shall depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished. The Contracting Officer will use, but is not limited to, the following conditions to review compliance with this paragraph:

1 Continuous Flow - Diagrams shall show a continuous flow from left to right with no arrows from right to left. The activity number, description, duration, and estimated earned value shall be shown on the diagram.

2 Project Milestone Dates - Dates shall be shown on the diagram for start of project, any contract required interim completion dates, and contract completion dates.

3 Critical Path - The critical path shall be clearly shown.

4 Banding - Activities shall be grouped to assist in the understanding of the activity sequence. Typically, this flow will group activities by category of work, work area and/or responsibility.

5 Earning (S-Curves) - Earnings (cash flow) curves (as required for submissions) shall show scheduled ES/EF and LS/LF curves. The monthly updates must indicate the actual progress plotted as of the data date. The cash flow curves are affected by the assigned cost and duration of the activities. The LS/LF cash flow curve is expected approximate 40% earning (without stored material) @ 50% of the contract duration and 70% earning @ 70% of contract duration. Earnings curves showing projected early and late earnings and earnings to date.

6.19.2.7 PERIODIC PROGRESS MEETINGS

- a) There will be two progress meetings for the review and updating of the project scheduling.

A progress update meeting will be held at the onsite between USACE and the authorized contractor representatives, on the agreed cut-off date established at the pre-construction conference. During this meeting the Contractor shall indicate its requested percentage completed on each activity on which there was a revised percentage of completion. The Contracting Officer must approve actual progress percentages for each Progress meetings to discuss payment shall include a monthly onsite meeting or other regular intervals mutually agreed to at the pre-construction conference. During this meeting the Contractor shall describe, on an activity-by-activity basis, all proposed revisions and adjustments to the project schedule required to reflect the current status of the project. The Contracting Officer will approve activity progress, proposed revisions, and adjustments as appropriate.

- b) The updated progress data will be evaluated at the second progress meeting.

A progress evaluation meeting shall be held with the contractor, after the updating of the current progress period work activities percentage is complete including modifications and adverse weather activities, to evaluate progress and the NAS schedule.

Adjustments to the NAS schedule. Update information must include the Actual Start Dates, Actual Finish Dates, Remaining Durations, and Cost to Date. The Contractor must address all the activities on an activity-by-activity basis during the second progress meeting.

The monthly updated NAS schedule is submitted to the Contracting Officer, for approval, with the contractor's request for progress payment. The evaluation will include a review of actual durations compared to scheduled durations for critical and non-critical activities, progress on critical activities and near critical activities, trends, and current/potential problem areas, cash flow progress, and projected workflow of activities.

The contractor's narrative report shall be available for review at least three days prior to the second progress meeting.

- c) Meeting Attendance

The Contractor's Project Manager and Scheduler shall attend the regular progress meeting.

- d) Update Submission Following Progress Meeting

A complete update of the project schedule containing all approved progress, revisions, and adjustments, based on the regular progress meeting, shall be submitted not later than 4 working days after the monthly progress meeting.

- e) Progress Meeting Contents

Update information, including Actual Start Dates, Actual Finish Dates, Remaining Durations, and Cost-to-Date shall be subject to the approval of the Contracting Officer. As a minimum, the Contractor shall address the following items on an activity by activity basis during each progress meeting.

1 Start and Finish Dates - The Actual Start and Actual Finish dates for each activity currently in-progress or completed.

2 Time Completion - The estimated Remaining Duration for each activity in-progress. Time-based progress calculations shall be based on Remaining Duration for each activity.

3 Cost Completion - The earnings for each activity started. Payment will be based on earnings for each in-progress or completed activity. Payment for individual activities will not be made for work that contains quality defects. A portion of the overall project amount may be retained based on delays of activities.

4 Logic Changes - All logic changes pertaining to NTP on change orders, change orders to be incorporated into the schedule, contractor proposed changes in work sequence, corrections to schedule logic for out-of-

sequence progress, lag durations, and other changes that have been made pursuant to contract provisions shall be specifically identified and discussed.

5 Other Changes - Other changes required due to delays in completion of any activity or group of activities include:

- a. Delays beyond the Contractor's control, such as strikes and unusual weather.
- b. Delays encountered due to submittals, Government Activities, deliveries or work stoppages which make re-planning the work necessary.
- c. Changes required to correct a schedule which does not represent the actual or planned prosecution and progress of the work.

6.19.2.8 REQUESTS FOR TIME EXTENSIONS

In the event the Contractor requests a time extension of the contract completion date, or any interim milestone date, the Contractor shall furnish the following for a determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract: justification, project schedule data, and supporting evidence as the Contracting Officer may deem necessary. Submission of proof of delay shall be based on a subnet/fragnet of work activities, revised activity logic, duration, and costs (updated to the specific date that the delay occurred) are required for any time extension approvals. The project schedule shall clearly display that the Contractor has used, in full, all the float time available for the work involved with this request. Actual delays that are found to be caused by the Contractor's own actions, which result in the extension of the schedule, shall not be a cause for a time extension to the contract completion date.

a) Justification of Delay

The project schedule shall clearly display that the Contractor has used, in full, all the float time available for the work involved with this request. The Contracting Officer's determination as to the number of allowable days of contract extension shall be based upon the project schedule updates in effect for the time period in question, and other factual information. Actual delays that are found to be caused by the Contractor's own actions, which result in the extension of the schedule, will not be a cause for a time extension to the contract completion date.

b) Submission Requirements for Time Extension Requests

The Contractor shall submit a comprehensive time analysis and justification for each "Request for Proposal" for a change in the contract, based upon the most recent approved schedule update at the time of the RFP issued. Such a time analysis and justification shall be in accordance with the requirements of other appropriate Contract Clauses and shall include, as a minimum:

1. A subnet/fragnet of activities indicating all new change activities and the affect on existing schedule activities.
2. A brief explanation of the causes of the change.
3. An analysis of the overall impact the subnet/fragnet has when applied to the current-updated approved NAS schedule.
4. Activities impacted in each justification for change shall be identified by a unique activity code contained in the required data file.
5. Modifications to the contract
6. Unpriced, unilateral and bilateral (without agreement on time) modifications

Upon receipt of the signed SF 30, for un-priced and unilateral modifications (or bilateral modifications with agreement on costs without an agreement on time, the Contractor shall submit proposed schedule revisions (in the form of a proposed subnet/fragnet) to the Contracting Officer for approval, within 14 days of the SF 30 being

issued. The proposed (subnet/fragnet) revisions to the schedule will be approved by the Contracting Officer prior to application of those changes within the project schedule.

Should the contractor fail or refuse to submit the provisions, the Contracting Officer may furnish the Contractor suggested (subnet/fragnet) revisions to the project schedule.

Upon receipt, the Contractor shall include these subnet/fragnet revisions in the project schedule.

If the Contractor has any objections to the revisions furnished by the Contracting Officer, the Contractor shall advise the Contracting Officer within 14 days of receipt of the revisions.

Regardless of the objections, the Contractor shall continue to update the schedule with the Contracting Officer's revisions until a mutual agreement on the revisions is reached.

If the Contractor fails to submit alternative revisions within 2 weeks of receipt of the Contracting officer's proposed revisions, the contractor will be deemed to have concurred with the Contracting Officer's proposed revisions. The proposed revisions will be the basis for an "equitable adjustment" for performance of the work.

Bilateral modifications shall be entered into the NAS schedule, utilizing the subnet/fragnet as agreed during negotiations, immediately after receipt of signed SF 30. Entries to the schedule must be approved by Contracting Officer.

All modifications subnets/fragnets shall be applied to the NAS schedule immediately in the sequence in which they were finalized (received signed SF 30). The modification with time extension shall result in new work activities entered adjacent to the critical path work activity affected by the modification.

Weather time extensions must be included monthly upon receipt of the written results of the monthly weather evaluation from the Contracting Officer.

c) Contractor falls behind the approved project schedule

If the Contractor falls behind its approved schedule, (behind the LS/LF cash flow curve or more than 10 work days of negative float) or performs the work in such a manner that the network diagram and mathematical analysis no longer indicate reasonable logic and duration for completion of the work by the current contract completion date, as determined by the Contracting Officer, the Contractor shall promptly provide a supplemental NAS recovery or completion schedule for completion by the current completion date, by reducing the remaining durations, revising logic, or adjusting resources onsite (in addition to the original approved NAS schedule) as approved by the Contracting Officer. The supplemental schedule shall be resource loaded with crew size and productivity for each remaining activity, and indicating overtime, weekend work, double shifts needed to regain the schedule, in accordance with FAR 52.236-15, without additional cost to the Government. The supplement schedule shall not replace the original approved schedule as the official contract schedule. The original approved schedule shall be updated monthly (in addition to the supplemental schedule) and monitored by the contractor and the Contracting Officer to determine the effect of the supplemental schedule progress has on the contract progress to regain its rate of progress for timely completion as specified.

The Contractor shall not artificially improve its progress by revising the schedule logic restraints or shortening future work activity durations. The contractor may improve its progress by performing sequential work activities concurrently or by performing activities more quickly than planned, but such improvements shall be indicated on a supplement schedule and shall not be recorded on the official until they have actually been achieved by the contractor. The additional resources required to improve the progress must be evident on the work site.

Failure of the contractor to perform work and maintain progress in accordance with the supplemental recovery or completion schedule may result in an interim and final unsatisfactory performance rating and/or may result in corrective action by the contracting officer in accordance with FAR 52.236-15.

The Contractor shall submit a justification for each request for a change in the contract completion date of less than 2 weeks based upon the most recent schedule update at the time of the NTP or constructive direction issued for the change. Such a request shall be in accordance with the requirements of other appropriate Contract Clauses and shall include, as a minimum:

1. A list of affected activities, with their associated project schedule activity number.
2. A brief explanation of the causes of the change.
3. An analysis of the overall impact of the changes proposed.
4. A sub-network of the affected area.

Activities impacted in each justification for change shall be identified by a unique activity code contained in the required data file.

d) Additional Submission Requirements

For any requested time extension of over 2 weeks, the Contracting Officer may request an interim update with revised activities for a specific change request. The Contractor shall provide this disk within 4 days of the Contracting Officer's request.

6.19.2.9 DIRECTED CHANGES

If the NTP is issued for changes prior to settlement of price and/or time, the Contractor shall submit proposed schedule revisions to the Contracting Officer within 2 weeks of the NTP being issued. The proposed revisions to the schedule will be approved by the Contracting Officer prior to inclusion of those changes within the project schedule. If the Contractor fails to submit the proposed revisions, the Contracting Officer may furnish the Contractor with suggested revisions to the project schedule. The Contractor shall include these revisions in the project schedule until revisions are submitted and final changes and impacts have been negotiated. If the Contractor has any objections to the revisions furnished by the Contracting Officer, the Contractor shall advise the Contracting Officer within 2 weeks of receipt of the revisions. Regardless of the objections, the Contractor shall continue to update the schedule with the Contracting Officer's revisions until a mutual agreement in the revisions is reached. If the Contractor fails to submit alternative revisions within 2 weeks of receipt of the Contracting Officer's proposed revisions, the Contractor will be deemed to have concurred with the Contracting Officer's proposed revisions. The proposed revisions will then be the basis for an equitable adjustment for performance of the work.

6.19.2.10 OWNERSHIP OF FLOAT

Float available in the schedule, at any time, shall not be considered for the exclusive use of either the Government or the Contractor.

6.19.3 SUPPLEMENTAL SUBMITTAL PROCEDURES

The following are submittals and submittal procedures to supplement those described in Section 01.33.00.

6.19.3.1 Submittal Descriptions (SD)

SD-01 Preconstruction Submittals

- ⌚ Activity Hazard Analysis (AHA)
- ⌚ Design Network Analysis Schedule
- ⌚ Crane Critical Lift Plan

6.19.3.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SC-01 preconstruction Submittals

Submittal register; G

6.19.3.3 GOVERNMENT REVIEW SCHEDULING

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. Adequate time (a minimum of 30 calendar days exclusive of mailing time) shall be allowed and shown on the register for review and approval. No delay damages or time extensions will be allowed for time lost in late submittals.

a) Pre-Construction Submittal Scheduling

Pre-Construction submittals shall be scheduled and shown on the submittal register to allow a minimum of 30 calendar days (exclusive of mailing time) for review and approval. No delay damages or time extensions will be allowed for time lost in late submittals.

b) Design Submittal Scheduling

Design submittals shall be submitted in accordance with the requirements of Section 01 33.16 "Design After Award".

6.19.3.4 SUBMITTAL PROCEDURES (Refer to Paragraph 1.11)

Submittals shall be made as follows:

a) Procedures

1. The Contractor shall be responsible for the scheduling and control of all submittals. The Contractor is responsible for confirming that the submittal register includes all submittals required by the contract documents.
2. In addition to those items listed on ENG Form 4288, the Contractor will furnish submittals for any deviation from the plans or specifications. The scheduled need dates must be recorded on the document for each item for control purposes and critical items must be tied to the Contractor's approved schedule where applicable.
3. The Contractor will submit to the Contracting Officer for approval a minimum of five copies of all G/RE (Resident/Area Office Review), G/ED (Engineering Division Review) or G/AE (Architect-Engineer Review) level submittals. Three copies of all FIO level submittals will be provided. The number of copies of submittals specified in this portion of the contract shall be complied with in lieu of four copies as specified by FAR 52.236-21.
4. For those contracts requiring Network Analysis System (NAS), the Contractor will schedule on the NAS critical items of equipment submittals and procurement activities which will, or have the potential to, significantly impact project completion. The inclusion or exclusion of critical items shall be subject to the approval of the Contracting Officer. Where ENG Form 4025 must be submitted prior to approval of the Construction Progress Schedule, the Contractor shall submit an initial annotated ENG Form 4288 upon which dates for submittal, approval and delivery of procurement items shall be included for the first 60 days of the work. Upon approval of the Construction Progress Schedule, or no later than 60 days after Notice to Proceed, the Contractor shall submit final annotated copies of ENG Form 4288. Dates shall be coordinated with the approved Construction Progress Schedule to logically interface with the sequence of construction. Critical item numbers will be shown on the listing if NAS is required.
5. Furnishing the schedule shall not be interpreted as relieving the Contractor of his obligation to comply with all the specification requirements for the items on the schedule. Contractor's Quality Control representative shall review the listing at least every 30 days and take appropriate action to maintain an effective system. The Contractor shall furnish a list each 30 days of all submittals on which either Government's or Contractor's action is past due. He shall also furnish revised due dates in those cases when the original submittal schedule is no longer realistic. This monthly list of delayed items shall also be annotated by the Contractor to show what corrective action he is taking with regard to slippages in submittal schedule which are attributable to actions by him, his subcontractors, or suppliers.

6. The Contractor shall provide a complete updated submittal register indicating the current status of all submittals when requested by the Contracting Officer in order to assure himself the schedule is being maintained.
7. The Contractor shall certify that each submittal is correct and in strict conformance with the contract drawings and specifications. All submittals not subject to the approval of the Contracting Officer will be submitted for information purposes only.
8. No Corps of Engineers action will be required prior to incorporating these items into the work, but the submittal shall be furnished to the Area/Resident Engineer not less than 2 weeks prior to procurement of Contractor certified material, equipment, etc.
9. These Contractor approved submittals will be used to verify that material received and used in the job is the same as that described and approved and will be used as record copies. All samples of materials submitted as required by these specifications shall be properly identified and labeled for ready identification, and upon being certified by the Contractor and reviewed by the Contracting Officer, shall be stored at the site of the work for job site use until all work has been completed and accepted by the Contracting Officer. Delegation of this approval authority to Contractor Quality Control does not relieve the Contractor from the obligation to conform to any contract requirement and will not prevent the Contracting Officer from requiring removal and replacement of construction not in contract conformance; nor does it relieve the Contractor from the requirement to furnish "samples" for testing by the Government Laboratory or check testing by the Government in those instances where the technical specifications so prescribe.
10. Contractor certified drawings will be subject to quality assurance review by the Government at any time during the duration of the contract. No adjustment for time or money will be allowed for corrections required as a result of noncompliance with plans and specifications.
11. Submittals Requiring Government Approval (G/ED Level, G/RE Level or G/AE level). Where the review authority is designated to the Government, the Contractor is required to sign the certification on ENG Form 4025 in the box beside the remarks block in Section I. The Government will code the items in block h and sign the approval action block in Section II as the approving authority.
12. Operating and Maintenance Instructions. Six complete sets of instructions containing the manufacturer's operating and maintenance instructions for each piece of equipment shall be furnished. Each set shall be permanently bound and shall have a hard cover. One complete set shall be furnished at the time test procedures are submitted. Remaining sets shall be furnished before the contract is completed. The following identification shall be inscribed on the covers: The words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the facility, name of the Contractor, and contract number. Fly sheets shall be placed before instructions covering each subject. Instruction sheets shall be approximately 8-1/2 by 11 inches, with large sheets of drawings folded in. Instructions shall include but are not limited to:
 - a. System layout showing piping, valves and controls;
 - b. Approved wiring and control diagrams;
 - c. A control sequence describing startup, operation and shutdown;
 - d. Operating and maintenance instructions for each piece of equipment, including lubrication instructions and troubleshooting guide; and
 - e. Manufacturer's bulletins, cuts and descriptive data; parts lists and recommended parts.
13. The Government will further discuss and detail the required submittal procedures at the Pre-Construction Conference.
14. If the Government performs a conformance review of other Designer of Record approved submittals, the submittals will be so identified and returned, as described above.
15. For design-build construction the Government will retain 2 copies of information only submittals.

6.19.4 SAFETY AND OCCUPATIONAL HEALTH REQUIREMENTS

6.19.4.1 GENERAL

a) REFERENCES

Refer to APPLICABLE CRITERIA in Paragraph 4.

b) SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Government acceptance is required for submittals with a "G, A" designation.

SD-01 Preconstruction Submittals

Accident Prevention Plan (APP); G, A

Activity Hazard Analysis (AHA); G, A

Crane Critical Lift Plan; G, A

Proof of qualification for Crane Operators; G, A

SD-06 Test Reports

Reports

Submit reports as their incidence occurs, in accordance with the requirements of the paragraph entitled, "Reports."

Accident Reports

Monthly Exposure Reports

Crane Reports

Regulatory Citations and Violations

SD-07 Certificates

Confined Space Entry Permit

Hot work permit

Certificate of Compliance (Crane)

Submit one copy of each permit/certificate attached to each Daily Quality Control Report.

c) DEFINITIONS

1. High Visibility Accident. Any mishap which may generate publicity and/or high visibility.

2. Medical Treatment. Treatment administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does not include first aid treatment even though provided by a physician or registered personnel.

3. Recordable Injuries or Illnesses. Any work-related injury or illness that results in:
 - a. Death, regardless of the time between the injury and death, or the length of the illness;
 - b. Days away from work (any time lost after day of injury/illness onset);
 - c. Restricted work;
 - d. Transfer to another job;
 - e. Medical treatment beyond first aid;
 - f. Loss of consciousness; or
 - g. A significant injury or illness diagnosed by a physician or other licensed health care professional, even if it did not result in (1) through (6) above.
4. "USACE" property and equipment specified in USACE EM 385-1-1 should be interpreted as Government property and equipment.

6.19.4.2 REGULATORY REQUIREMENTS

In addition to the detailed requirements included in the provisions of this contract, work performed shall comply with USACE EM 385-1-1, and the following federal, state, and local, laws, ordinances, criteria, rules and regulations. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting work. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements shall apply.

6.19.4.3 SITE QUALIFICATIONS, DUTIES AND MEETINGS

a) Personnel Qualifications

1. Site Safety and Health Officer (SSHO): Site Safety and Health Officer (SSHO) shall be provided at the work site at all times to perform safety and occupational health management, surveillance, inspections, and safety enforcement for the Contractor. The Contractor Quality Control (QC) person cannot be the SSHO on this project, even though the QC has safety inspection responsibilities as part of the QC duties. The SSHO shall meet the following requirements:

Level 3:

A minimum of 5 years safety work on similar projects.

30-hour OSHA construction safety class or equivalent within the last 5 years.

An average of at least 24 hours of formal safety training each year for the past 5 years.

Competent person training as needed.

2. Crane Operators: Crane operators shall meet the requirements in USACE EM 385-1-1, Section 16 and Appendix G. In addition, for mobile cranes with Original Equipment Manufacturer (OEM) rated capacities of 50,000 pounds or greater, crane operators shall be designated as qualified by a source that qualifies crane operators (i.e., union, a government agency, or and organization that tests and qualifies crane operators). Proof of current qualification shall be provided.

b) Personnel Duties

1. Site Safety and Health Officer (SSHO)/Superintendent

- a. Conduct daily safety and health inspections and maintain a written log which includes area/operation inspected, date of inspection, identified hazards, recommended corrective actions, estimated and actual dates of corrections. Safety inspection logs shall be attached to the Contractors' daily quality control report.
 - b. Conduct mishap investigations and complete required reports. Maintain the OSHA Form 300 and Daily Production reports for prime and sub-contractors.
 - c. Maintain applicable safety reference material on the job site.
 - d. Attend the pre-construction conference, pre-work meetings including preparatory inspection meeting, and periodic in-progress meetings.
 - e. Implement and enforce accepted APPS and AHAs.
 - f. Maintain a safety and health deficiency tracking system that monitors outstanding deficiencies until resolution. A list of unresolved safety and health deficiencies shall be posted on the safety bulletin board.
 - g. Ensure sub-contractor compliance with safety and health requirements.
2. Failure to perform the above duties will result in dismissal of the superintendent and/or SSHO, and a project work stoppage. The project work stoppage will remain in effect pending approval of a suitable replacement.

c) Meetings

Preconstruction Conference

1. Contractor representatives who have a responsibility or significant role in accident prevention on the project shall attend the preconstruction conference. This includes the project superintendent, site safety and health officer, quality control supervisor, or any other assigned safety and health professionals who participated in the development of the APP (including the Activity Hazard Analyses (AHAs) and special plans, program and procedures associated with it).
2. The Contractor shall discuss the details of the submitted APP to include incorporated plans, programs, procedures and a listing of anticipated AHAs that will be developed and implemented during the performance of the contract. This list of proposed AHAs will be reviewed at the conference and an agreement will be reached between the Contractor and the Contracting Officer's representative as to which phases will require an analysis. In addition, a schedule for the preparation, submittal, review, and acceptance of AHAs shall be established to preclude project delays.
3. Deficiencies in the submitted APP will be brought to the attention of the Contractor at the preconstruction conference, and the Contractor shall revise the plan to correct deficiencies and re-submit it for acceptance. Work shall not begin until there is an accepted APP.
4. The functions of a Preconstruction conference may take place at the Post-Award Kickoff meeting for Design Build Contracts.

1. ACCIDENT PREVENTION PLAN (APP)

- a. The Contractor shall use a qualified person to prepare the written site-specific APP. Prepare the APP in accordance with the format and requirements of USACE EM 385-1-1 and as supplemented herein. Cover all paragraph and subparagraph elements in USACE EM 385-1-1, Appendix A, "Minimum Basic Outline for Accident Prevention Plan". Specific requirements for some of the APP elements are described below. The APP shall be job-specific and shall address any unusual or unique aspects of the project or activity for which it is written. The APP shall interface with the Contractor's overall safety and health program. Any portions of the Contractor's overall safety and health program referenced in the APP shall be included in the applicable APP element and made site-specific. The Government considers the Prime Contractor to be the "controlling authority" for all work site safety and health of the subcontractors. Contractors are responsible for informing their subcontractors of the safety provisions under the terms of the contract and the penalties for noncompliance, coordinating the work to prevent one craft from interfering with or creating hazardous working conditions for other crafts, and inspecting

subcontractor operations to ensure that accident prevention responsibilities are being carried out. The APP shall be signed by the person and firm (senior person) preparing the APP, the Contractor, the on-site superintendent, the designated site safety and health officer and any designated CSP and/or CIH.

- b. Submit the APP to the Contracting Officer 15 calendar days prior to the date of the preconstruction conference for acceptance. Work cannot proceed without an accepted APP.
- c. Once accepted by the Contracting Officer, the APP and attachments will be enforced as part of the contract. Disregarding the provisions of this contract or the accepted APP will be cause for stopping of work, at the discretion of the Contracting Officer, until the matter has been rectified.
- d. Once work begins, changes to the accepted APP shall be made with the knowledge and concurrence of the Contracting Officer, project superintendent, SSHO and quality control manager. Should any hazard become evident, stop work in the area, secure the area, and develop a plan to remove the hazard. Notify the Contracting Officer within 24 hours of discovery. Eliminate/remove the hazard. In the interim, all necessary action shall be taken to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public (as defined by ANSI/ASSE A10.34,) and the environment.
- e. Copies of the accepted plan will be maintained at the resident engineer's office and at the job site.
- f. The APP shall be continuously reviewed and amended, as necessary, throughout the life of the contract. Unusual or high-hazard activities not identified in the original APP shall be incorporated in the plan as they are discovered.

6.19.4.4 ACTIVITY HAZARD ANALYSIS (AHA)

- a) The Activity Hazard Analysis (AHA) format shall be in accordance with USACE EM 385-1-1. Submit the AHA for review at least 15 calendar days prior to the start of each phase. Format subsequent AHAs as amendments to the APP. The analysis should be used during daily inspections to ensure the implementation and effectiveness of the activity's safety and health controls.
- b) The AHA list will be reviewed periodically (at least monthly) at the Contractor supervisory safety meeting and updated as necessary when procedures, scheduling, or hazards change.
- c) The activity hazard analyses shall be developed using the project schedule as the basis for the activities performed. Any activities listed on the project schedule will require an AHA. The AHAs will be developed by the contractor, supplier or subcontractor and provided to the prime contractor for submittal to the Contracting Officer.

6.19.4.5 DISPLAY OF SAFETY INFORMATION

Within 1 calendar days after commencement of work, erect a safety bulletin board at the job site. The safety bulletin board shall include information and be maintained as required by EM 385-1-1, section 01.A.06.

6.19.4.6 SITE SAFETY REFERENCE MATERIAL

Maintain safety-related references applicable to the project, including those listed in the article "References." Maintain applicable equipment manufacturer's manuals.

6.19.4.7 EMERGENCY MEDICAL TREATMENT

Contractors will arrange for their own emergency medical treatment. Government has no responsibility to provide emergency medical treatment.

6.19.4.8 REPORTS

- a) Accident Reports - For recordable injuries and illnesses, and property damage accidents resulting in at least \$2,000 in damages, the Prime Contractor shall conduct an accident investigation to establish the root cause(s) of the accident, complete the USACE Accident Report Form 3394 and provide the report to the

Contracting Officer within 5 calendar day(s) of the accident. The Contracting Officer will provide copies of any required or special forms.

- b) Accident Notification - Notify the Contracting Officer as soon as practical, but not later than four hours, after any accident meeting the definition of Recordable Injuries or Illnesses or High Visibility Accidents, property damage equal to or greater than \$2,000, or any weight handling equipment accident. Information shall include contractor name; contract title; type of contract; name of activity, installation or location where accident occurred; date and time of accident; names of personnel injured; extent of property damage, if any; extent of injury, if known, and brief description of accident (to include type of construction equipment used, PPE used, etc.). Preserve the conditions and evidence on the accident site until the Government investigation team arrives on-site and Government investigation is conducted.
- c) Monthly Exposure Reports - Monthly exposure reporting to the Contracting Officer is required to be attached to the monthly billing request. This report is a compilation of employee-hours worked each month for all site workers, both prime and subcontractor. The Contracting Officer will provide copies of any special forms.
- d) Crane Reports - Submit crane inspection reports required in accordance with USACE EM 385-1-1, Appendix H and as specified herein with Daily Reports of Inspections.
- e) Certificate of Compliance - The Contractor shall provide a Certificate of Compliance for each crane entering an activity under this contract (see Contracting Officer for a blank certificate). Certificate shall state that the crane and rigging gear meet applicable OSHA regulations (with the Contractor citing which OSHA regulations are applicable, e.g., cranes used in construction, demolition, or maintenance shall comply with 29 CFR 1926 and USACE EM 385-1-1 section 16 and Appendix H. Certify on the Certificate of Compliance that the crane operator(s) is qualified and trained in the operation of the crane to be used. The Contractor shall also certify that all of its crane operators working on the DOD activity have been trained in the proper use of all safety devices (e.g., anti-two block devices). These certifications shall be posted on the crane.

6.19.4.9 HOT WORK

- a) Prior to performing "Hot Work" (welding, cutting, etc.) or operating other flame-producing/spark producing devices, a written permit shall be requested from the Fire Division. CONTRACTORS ARE REQUIRED TO MEET ALL CRITERIA BEFORE A PERMIT IS ISSUED. The Contractor will provide at least two (2) twenty (20) pound 4A:20 BC rated extinguishers for normal "Hot Work". All extinguishers shall be current inspection tagged, approved safety pin and tamper resistant seal. It is also mandatory to have a designated FIRE WATCH for any "Hot Work" done at this activity. The Fire Watch shall be trained in accordance with NFPA 51B and remain on-site for a minimum of 30 minutes after completion of the task or as specified on the hot work permit.
- b) When starting work in the facility, Contractors shall require their personnel to familiarize themselves with the location of the nearest fire alarm boxes and place in memory the emergency Fire Division phone number. ANY FIRE, NO MATTER HOW SMALL, SHALL BE REPORTED TO THE RESPONSIBLE FIRE DIVISION IMMEDIATELY.

6.19.4.10 CONSTRUCTION AND/OR OTHER WORK

- a) Hazardous Material Exclusions - Notwithstanding any other hazardous material used in this contract, radioactive materials or instruments capable of producing ionizing/non-ionizing radiation (with the exception of radioactive material and devices used in accordance with USACE EM 385-1-1 such as nuclear density meters for compaction testing and laboratory equipment with radioactive sources) as well as materials which contain asbestos, mercury or polychlorinated biphenyls, di-isocyanates, lead-based paint are prohibited. The Contracting Officer, upon written request by the Contractor, may consider exceptions to the use of any of the above excluded materials.
- b) Unforeseen Hazardous Material - If material, not indicated, that may be hazardous to human health upon disturbance during construction operations is encountered, stop that portion of work and notify the Contracting Officer immediately. Within 14 calendar days the Government will determine if the material is hazardous. If material is not hazardous or poses no danger, the Government will direct the Contractor to proceed without change. If material is hazardous and handling of the material is necessary to accomplish the work, the Government will issue a modification pursuant to "FAR 52.243-4, Changes" and "FAR 52.236-2, Differing Site Conditions."

6.19.4.11 PRE-OUTAGE COORDINATION MEETING

Contractors are required to apply for utility outages at least 15 days in advance. As a minimum, the request should include the location of the outage, utilities being affected, duration of outage and any necessary sketches. Special requirements for electrical outage requests are contained elsewhere in this specification section. Once approved, and prior to beginning work on the utility system requiring shut down, the Contractor shall attend a pre-outage coordination meeting with the Contracting Officer and the Public Utilities representative to review the scope of work and the lock-out/tag-out procedures for worker protection. No work will be performed on energized electrical circuits unless proof is provided that no other means exist.

6.19.4.12 FALL HAZARD PROTECTION AND PREVENTION PROGRAM

The Contractor shall establish a fall protection and prevention program, for the protection of all employees exposed to fall hazards. The program shall include company policy; identify responsibilities, education and training requirements, fall hazard identification, prevention and control measures, inspection, storage, care and maintenance of fall protection equipment and rescue and evacuation procedures.

1. Training - The Contractor shall institute a fall protection training program. As part of the Fall Hazard Protection and Prevention Program, the Contractor shall provide training for each employee who might be exposed to fall hazards. A competent person for fall protection shall provide the training. Training requirements shall be in accordance with USACE EM 385-1-1, section 21.A.16.

2. Fall Protection Equipment and Systems - The Contractor shall enforce use of the fall protection equipment and systems designated for each specific work activity in the Fall Protection and Prevention Plan and/or AHA at all times when an employee is exposed to a fall hazard. Employees shall be protected from fall hazards as specified in EM 385-1-1, section 21. In addition to the required fall protection systems, safety skiff, personal floatation devices, life rings etc., are required when working above or next to water in accordance with USACE EM 385-1-1, paragraphs 05.H. and 05.I. Personal fall arrest systems are required when working from an articulating or extendible boom, swing stages, or suspended platform. In addition, personal fall arrest systems are required when operating other equipment such as scissor lifts if the work platform is capable of being positioned outside the wheelbase. The need for tying-off in such equipment is to prevent ejection of the employee from the equipment during raising, lowering, or travel. Fall protection must comply with 29 CFR 1926.500, Subpart M, USACE EM 385-1-1 and ANSI A10.32.

Personal Fall Arrest Equipment - Personal fall arrest equipment, systems, subsystems, and components shall meet ANSI Z359.1. Only a full-body harness with a shock-absorbing lanyard or self-retracting lanyard is an acceptable personal fall arrest body support device. Body belts may only be used as a positioning device system (for uses such as steel reinforcing assembly and in addition to an approved fall arrest system). Harnesses shall have a fall arrest attachment affixed to the body support (usually a Dorsal D-ring) and specifically designated for attachment to the rest of the system. Only locking snap hooks and carabiners shall be used. Webbing, straps, and ropes shall be made of synthetic fiber. The maximum free fall distance when using fall arrest equipment shall not exceed 1.8 m (6 feet). The total fall distance and any swinging of the worker (pendulum-like motion) that can occur during a fall shall always be taken into consideration when attaching a person to a fall arrest system.

3. Fall Protection for Roofing Work - fall protection controls shall be implemented based on the type of roof being constructed and work being performed. The roof area to be accessed shall be evaluated for its structural integrity including weight-bearing capabilities for the projected loading.

a. Low Sloped Roofs:

(1) For work within 6 feet of an edge, on low-slope roofs, personnel shall be protected from falling by use of personal fall arrest systems, guardrails, or safety nets.

(2) For work greater than 6 feet from an edge, warning lines shall be erected and installed in accordance with 29 CFR 1926.500 and USACE EM 385-1-1.

b. Steep-Sloped Roofs: Work on steep-sloped roofs requires a personal fall arrest system, guardrails with toe-boards, or safety nets. This requirement also includes residential or housing type construction.

4. Existing Anchorage - Existing anchorages, to be used for attachment of personal fall arrest equipment, shall be certified (or re-certified) by a qualified person for fall protection in accordance with ANSI Z359.1. Existing horizontal lifeline anchorages shall be certified (or re-certified) by a registered professional engineer with experience in designing horizontal lifeline systems.
5. Horizontal Lifelines - Horizontal lifelines shall be designed, installed, certified and used under the supervision of a qualified person for fall protection as part of a complete fall arrest system which maintains a safety factor of 2 (29 CFR 1926.500).
6. Guardrails and Safety Nets - Guardrails and safety nets shall be designed, installed and used in accordance with EM 385-1-1 and 29 CFR 1926 Subpart M.
7. Rescue and Evacuation Procedures - When personal fall arrest systems are used, the contractor must ensure that the mishap victim can self-rescue or can be rescued promptly should a fall occur. A Rescue and Evacuation Plan shall be prepared by the contractor and include a detailed discussion of the following: methods of rescue; methods of self-rescue; equipment used; training requirement; specialized training for the rescuers; procedures for requesting rescue and medical assistance; and transportation routes to a medical facility. The Rescue and Evacuation Plan shall be included in the Activity Hazard Analysis (AHA) for the phase of work, in the Fall Protection and Prevention (FP&P) Plan, and the Accident Prevention Plan (APP).

6.19.4.13 EQUIPMENT

a) Material Handling Equipment -

1. Material handling equipment such as forklifts shall not be modified with work platform attachments for supporting employees unless specifically delineated in the manufacturer's printed operating instructions.
2. The use of hooks on equipment for lifting of material must be in accordance with manufacturer's printed instructions.
3. Operators of forklifts or power industrial trucks shall be licensed in accordance with OSHA.

b) Weight Handling Equipment

1. Cranes and derricks shall be equipped as specified in EM 385-1-1, section 16.
2. The Contractor shall comply with the crane manufacturer's specifications and limitations for erection and operation of cranes and hoists used in support of the work. Erection shall be performed under the supervision of a designated person (as defined in ASME B30.5). All testing shall be performed in accordance with the manufacturer's recommended procedures.
3. The Contractor shall comply with ASME B30.5 for mobile and locomotive cranes, ASME B30.22 for articulating boom cranes, ASME B30.3 for construction tower cranes, and ASME B30.8 for floating cranes and floating derricks.
4. Under no circumstance shall a Contractor make a lift at or above 90% of the cranes rated capacity in any configuration.
5. When operating in the vicinity of overhead transmission lines, operators and riggers shall be alert to this special hazard and shall follow the requirements of USACE EM 385-1-1 section 11 and ASME B30.5 or ASME B30.22 as applicable.
6. Crane suspended personnel work platforms (baskets) shall not be used unless the Contractor proves that using any other access to the work location would provide a greater hazard to the workers or is impossible. Personnel shall not be lifted with a line hoist or friction crane.
7. Portable fire extinguishers shall be inspected, maintained, and recharged as specified in NFPA 10, Standard for Portable Fire Extinguishers.

8. All employees shall be kept clear of loads about to be lifted and of suspended loads.
9. The Contractor shall use cribbing when performing lifts on outriggers.
10. The crane hook/block must be positioned directly over the load. Side loading of the crane is prohibited.
11. A physical barricade must be positioned to prevent personnel from entering the counterweight swing (tail swing) area of the crane.
12. Certification records which include the date of inspection, signature of the person performing the inspection, and the serial number or other identifier of the crane that was inspected shall always be available for review by Contracting Officer personnel.
13. Written reports listing the load test procedures used along with any repairs or alterations performed on the crane shall be available for review by Contracting Officer personnel.
14. Certify that all crane operators have been trained in proper use of all safety devices (e.g. anti-two block devices).

6.19.4.14 EXCAVATIONS

The competent person shall perform soil classification in accordance with 29 CFR 1926.

- a) Utility Locations - Prior to digging, the appropriate digging permit must be obtained. All underground utilities in the work area must be positively identified by a private utility locating service in addition to any station locating service and coordinated with the station utility department. Any markings made during the utility investigation must be maintained throughout the contract.
- b) Utility Location Verification - The Contractor must physically verify underground utility locations by hand digging using wood or fiberglass handled tools when any adjacent construction work is expected to come within three feet of the underground system. Digging within 2 feet of a known utility must not be performed by means of mechanical equipment; hand digging shall be used. If construction is parallel to an existing utility the utility shall be exposed by hand digging every 100 feet if parallel within 5 feet of the excavation.
- c) Shoring Systems - Trench and shoring systems must be identified in the accepted safety plan and AHA. Manufacture tabulated data and specifications or registered engineer tabulated data for shoring or benching systems shall be readily available on-site for review. Job-made shoring or shielding shall have the registered professional engineer stamp, specifications, and tabulated data. Extreme care must be used when excavating near direct burial electric underground cables.
- d) Trenching Machinery - Trenching machines with digging chain drives shall be operated only when the spotters/laborers are in plain view of the operator. Operator and spotters/laborers shall be provided training on the hazards of the digging chain drives with emphasis on the distance that needs to be maintained when the digging chain is operating. Documentation of the training shall be kept on file at the project site.

6.19.4.15 UTILITIES WITHIN CONCRETE SLABS ELECTRICAL

Utilities located within concrete slabs or pier structures, bridges, and the like, are extremely difficult to identify due to the reinforcing steel used in the construction of these structures. Whenever contract work involves concrete chipping, saw cutting, or core drilling, the existing utility location must be coordinated with station utility departments in addition to a private locating service. Outages to isolate utility systems shall be used in circumstances where utilities are unable to be positively identified. The use of historical drawings does not alleviate the contractor from meeting this requirement.

6.19.4.16 ELECTRICAL

- a) Conduct of Electrical Work - Underground electrical spaces must be certified safe for entry before entering to conduct work. Cables that will be cut must be positively identified and de-energized prior to performing each cut. Positive cable identification must be made prior to submitting any outage request for electrical systems.

Arrangements are to be coordinated with the Contracting Officer and Station Utilities for identification. The Contracting Officer will not accept an outage request until the Contractor satisfactorily documents that the circuits have been clearly identified. Perform all high voltage cable cutting remotely using hydraulic cutting tool. When racking in or live switching of circuit breakers, no additional person other than the switch operator will be allowed in the space during the actual operation. Plan so that work near energized parts is minimized to the fullest extent possible. Use of electrical outages clear of any energized electrical sources is the preferred method. When working in energized substations, only qualified electrical workers shall be permitted to enter. When work requires Contractor to work near energized circuits as defined by the NFPA 70, high voltage personnel must use personal protective equipment that includes, as a minimum, electrical hard hat, safety shoes, insulating gloves with leather protective sleeves, fire retarding shirts, coveralls, face shields, and safety glasses. In addition, provide electrical arc flash protection for personnel as required by NFPA 70E. Insulating blankets, hearing protection, and switching suits may also be required, depending on the specific job and as delineated in the Contractor's AHA.

b) Portable Extension Cords - Portable extension cords shall be sized in accordance with manufacturer ratings for the tool to be powered and protected from damage. All damaged extension cords shall be immediately removed from service. Portable extension cords shall meet the requirements of NFPA 70.

6.19.4.17 WORK IN CONFINED SPACES

The Contractor shall comply with the requirements in Section 06.I of USACE EM 385-1-1, OSHA 29 CFR 1910.146 and OSHA 29 CFR 1926.21(b)(6). Any potential for a hazard in the confined space requires a permit system to be used.

6.19.5 TEMPORARY CONSTRUCTION FACILITIES

6.19.5.1 GENERAL

The following are Temporary Construction Facilities to supplement those described in Section 01.50 02.

Refer to APPLICABLE CRITERIA in Paragraph 4.

6.19.5.2 IDENTIFICATION OF EMPLOYEES

The Contractor shall be responsible for furnishing to each employee, and for requiring each employee engaged on the work to display, identification as approved and directed by the Contracting Officer. Prescribed identification shall immediately be delivered to the Contracting Officer for cancellation upon release of any employee. When required, the Contractor shall obtain and provide fingerprints of persons employed on the project. Contractor and subcontractor personnel shall wear identifying markings on hard hats clearly identifying the company for whom the employee works.

6.19.5.3 AVAILABILITY AND USE OF UTILITY SERVICES

a) Payment for Utility Services

The Government will make all reasonably required utilities available to the Contractor from existing outlets and supplies, as specified in the contract. Unless otherwise provided in the contract, the amount of each utility service consumed shall be charged to or paid for by the Contractor at prevailing rates charged to the Government or, where the utility is produced by the Government, at reasonable rates determined by the Contracting Officer. The Contractor shall carefully conserve any utilities furnished without charge.

b) Meters and Temporary Connections

The Contractor is responsible for obtaining all meters and temporary connections for temporary facilities or temporary use. Utilities on Ft. Lee, including electric, water, sewer, telephone, and cable are operated by privatized utility companies. The Contractor shall coordinate all required temporary connections and/or metering for electric, water, and sewer with the Ft. Lee Directorate of Logistics/Directorate of Public Works (DPW) and set up accounts for payment of utility usage with DPW. The POC for this action is Ms. Arlene Day. The Contractor shall be required to contact the local telephone provider and local cable provider directly and coordinate and pay for all services required.

c) Sanitation

The Contractor shall provide and maintain within the construction area minimum field-type sanitary facilities approved by the Contracting Officer. Government toilet facilities will not be available to Contractor's personnel.

d) Telephone

The Contractor shall make arrangements and pay all costs for telephone facilities desired.

6.19.5.4 BULLETIN BOARD, PROJECT SIGN, AND PROJECT SAFETY SIGN

a) Bulletin Board

Immediately upon beginning of work, the Contractor shall provide a weatherproof glass-covered bulletin board not less than 36 by 48 inches in size for displaying the Equal Employment Opportunity poster, a copy of the wage decision contained in the contract, Wage Rate Information poster, and other information approved by the Contracting Officer. The bulletin board shall be located at the project site in a conspicuous place easily accessible to all employees, as approved by the Contracting Officer. Legible copies of the aforementioned data shall be displayed until work is completed. Upon completion of work the bulletin board shall be removed by and remain the property of the Contractor.

b) Project and Safety Signs

The requirements for the signs, their content, and location shall be provided at a location designated by the Contracting Officer. The signs shall be erected within 15 days after receipt of the Notice to Proceed. The data required by the safety sign shall be corrected daily, with light colored metallic or non-metallic numerals. Upon completion of the project, the signs shall be removed and disposed of by the Contractor.

1. Project Identification Signs shall be in accordance with EP 310-1-6A standards. See Appendix H, Figure 1.

2. Safety Sign - The safety sign shall conform to the requirements as indicated in Appendix H, Figure 2. The data required by the sign shall be corrected daily, with light colored metallic or non-metallic numerals. Numerals, including mounting hardware, shall be subject to the approval of the CO.

3. Sign Erection - The project sign shall be erected to conform to the requirements as indicated Appendix H, Figure 3.

6.19.5.5 PROTECTION AND MAINTENANCE OF TRAFFIC

a) During construction the Contractor shall provide access and temporary relocated roads as necessary to maintain traffic. The Contractor shall maintain and protect traffic on all affected roads during the construction period except as otherwise specifically directed by the Contracting Officer. Measures for the protection and diversion of traffic, including the provision of watchmen and flagmen, erection of barricades, placing of lights around and in front of equipment and the work, and the erection and maintenance of adequate warning, danger, and direction signs, shall be as required by the State and local authorities having jurisdiction. The traveling public shall be protected from damage to person and property. The Contractor's traffic on roads selected for hauling material to and the site shall interfere as little as possible with public traffic. The Contractor shall investigate the adequacy of existing roads and the allowable load limit on these roads. The Contractor shall be responsible for the repair of any damage to roads caused by construction operations.

b) Barricades: The Contractor shall erect and maintain temporary barricades to limit public access to hazardous areas. Such barricades shall be required whenever safe public access to paved areas such as roads, parking areas or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic. Barricades shall be securely placed, clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night.

6.19.5.6 CONTRACTOR'S TEMPORARY FACILITIES

a) Administrative Field Offices

The Contractor shall provide and maintain administrative field office facilities within the construction area at the designated site. Government office and warehouse facilities will not be available to the Contractor's personnel.

b) Project Area

The Contractor shall construct a temporary 6 foot high chain link fence around trailers and materials. The fence shall include plastic strip inserts, colored green, so that visibility through the fence is obstructed. Fence posts may be driven, in lieu of concrete bases, where soil conditions permit. Trailers, materials, or equipment shall not be placed or stored outside the fenced area unless such trailers, materials, or equipment are assigned a separate and distinct storage area by the Contracting Officer away from the vicinity of the construction site but within the military boundaries. Trailers, equipment, or materials shall not be open to public view with the exception of those items which are in support of ongoing work on any given day. Materials shall not be stockpiled outside the fence in preparation for the next day's work. Mobile equipment, such as tractors, wheeled lifting equipment, cranes, trucks, and like equipment, shall be parked within the fenced area at the end of each work day.

c) Supplemental Storage Area

Upon Contractor's request, the Contracting Officer will designate another or supplemental area for the Contractor's use and storage of trailers, equipment, and materials. This area may not be in close proximity of the construction site but shall be within the military boundaries. Fencing of materials or equipment will not be required at this site; however, the Contractor shall be responsible for cleanliness and orderliness of the area used and for the security of any material or equipment stored in this area. Utilities will not be provided to this area by the Government.

d) Appearance of Trailers

Trailers utilized by the Contractor for administrative or material storage purposes shall present a clean and neat exterior appearance and shall be in a state of good repair. Trailers which, in the opinion of the Contracting Officer, require exterior painting or maintenance will not be allowed on the military property.

e) Maintenance of Project Area

Fencing shall be kept in a state of good repair and proper alignment. Should the Contractor elect to traverse, with construction equipment or other vehicles, grassed or unpaved areas which are not established roadways, such areas shall be covered with a layer of gravel as necessary to prevent rutting and the tracking of mud onto paved or established roadways; gravel gradation shall be at the Contractor's discretion. Grass located within the boundaries of the construction site shall be mowed for the duration of the project. Grass and vegetation along fences, buildings, under trailers, and in areas not accessible to mowers shall be edged or trimmed neatly.

f) Security Provisions

Adequate outside security lighting shall be provided at the Contractor's temporary facilities. The Contractor shall be responsible for the security of its own equipment; in addition, the Contractor shall notify the appropriate law enforcement agency requesting periodic security checks of the temporary project field office.

6.19.5.7 GOVERNMENT FIELD OFFICE

The Contractor shall provide the Government Resident Engineer with an office, located on the site as directed by the Contracting Officer. The trailer shall be like new in appearance with at least one operable window in each exterior wall and an entrance landing and steps per 29 OER 1910 (OSHA Standards). Minimum square footage shall be 1440 SF. Space shall include heat, electric power, lighting, plumbing, air conditioning, and high speed broad band internet service from a local cable provider. Office space shall be provided with minimum of 7 desks with chairs, 7 three section and 3 five section bookshelves, a telephone/data jack at each desk plus one additional jack for a printer and one additional telephone jack from the fax machine, 4-4 drawer file cabinets or equal, plan table with plan and rack, mini-blinds in all windows, kitchen (with wet sink, 18 cf refrigerator, and microwave oven),

bottled water services with a dispenser that dispenses cold and hot water, toilet and lavatory in a separate room, including sewer and hot and cold water connections. One faucet at lavatory to include hot water, janitorial service shall be provided twice a week. A minimum 192 SF conference room shall also be provided which shall include a conference room table and 8 conference room chairs. Provide a storage room minimum of 48 SF. Contractor shall also provide and maintain a graveled parking area suitably sized for 7 full size vehicles. At completion of the project, the office shall remain the property of the Contractor and shall be removed from the site. Utilities shall be connected and disconnected in accordance with local codes and to the satisfaction of the Contracting Officer. The Contractor is responsible for payment of all utility usage, to include electric, water, sewer, telephone, and internet service. This project has multiple project sites, but only one Field Office Trailer is required and will be located at the direction of the Contracting Officer.

6.19.5.8 PLANT COMMUNICATION

Whenever the Contractor has the individual elements of its plant so located that operation by normal voice between these elements is not satisfactory, the Contractor shall install a satisfactory means of communication, such as telephone or other suitable devices. The devices shall be made available for use by Government personnel.

6.19.5.9 TEMPORARY PROJECT SAFETY FENCING

As soon as practicable, but not later than 15 days after the date established for commencement of work, the Contractor shall furnish and erect temporary project safety fencing at the work site. The safety fencing shall be a high visibility orange colored, high density polyethylene grid or approved equal, a minimum of 42 inches high, supported and tightly secured to steel posts located on maximum 10 foot centers, constructed at the approved location. The safety fencing shall be maintained by the Contractor during the life of the contract and, upon completion and acceptance of the work, shall become the property of the Contractor and shall be removed from the work site.

6.19.5.10 CLEANUP

Construction debris, waste materials, packaging material and the like shall be removed from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways shall be cleaned away. Materials resulting from demolition activities which are salvageable shall be stored within the fenced area described above or at the supplemental storage area. Stored material not in trailers, whether new or salvaged, shall be neatly stacked when stored.

6.19.5.11 RESTORATION OF STORAGE AREA

Upon completion of the project and after removal of trailers, materials, and equipment from within the fenced area, the fence shall be removed and will become the property of the Contractor. Areas used by the Contractor for the storage of equipment or material, or other use, shall be restored to the original or better condition. Gravel used to traverse grassed areas shall be removed and the area restored to its original condition, including top soil and seeding as necessary.

6.19.6 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

6.19.6.1 GOVERNMENT POLICY

Government policy is to apply sound environmental principles in the design, construction and use of facilities. As part of the implementation of that policy the Contractor shall: (1) practice efficient waste management when sizing, cutting, and installing products and materials and (2) use all reasonable means to divert construction and demolition waste from landfills and incinerators and to facilitate their recycling or reuse.

6.19.6.2 MANAGEMENT

The Contractor shall take a pro-active, responsible role in the management of construction and demolition waste and require all subcontractors, vendors, and suppliers to participate in the effort. Construction and demolition waste includes products of demolition or removal, excess or unusable construction materials, packaging materials for construction products, and other materials generated during the construction process but not incorporated into the work. In the management of waste consideration shall be given to the availability of viable markets, the condition of

the material, the ability to provide the material in suitable condition and in a quantity acceptable to available markets, and time constraints imposed by internal project completion mandates. The Contractor shall be responsible for implementation of any special programs involving rebates or similar incentives related to recycling of waste. Revenues or other savings obtained for salvage, or recycling shall accrue to the Contractor. Firms and facilities used for recycling, reuse, and disposal shall be appropriately permitted for the intended use to the extent required by federal, state, and local regulations.

6.19.6.3 CONSTRUCTION AND DEMOLITION (C&D) WASTE MANAGEMENT PLAN

A waste management plan shall be submitted within 15 days after notice to proceed and prior to initiating any site preparation work. At a minimum, the plan shall include the contractor's plan(s) for a minimum fifty percent (50%) diversion rate or justification for less than a fifty percent (50%) rate due to time and/or cost constraints as identified below. The plan shall include the following:

- a. Name of individuals on the Contractor's staff responsible for waste prevention and management.
- b. Actions that will be taken to reduce solid waste generation.
- c. Description of the specific approaches to be used in recycling/reuse of the various materials generated, including the areas and equipment to be used for processing, sorting, and temporary storage of wastes.
- d. Characterization, including estimated types and quantities, of the waste to be generated.
- e. Name of landfill and/or incinerator to be used and the estimated costs for use, assuming that there would be no salvage or recycling on the project.
- f. Identification of local and regional reuse programs, including non-profit organizations such as schools, local housing agencies, and organizations that accept used materials such as materials exchange networks and Habitat for Humanity.
- g. List of specific waste materials that will be salvaged for resale, salvaged and reused, or recycled. Recycling facilities that will be used shall be identified.
- h. Identification of materials that cannot be recycled/reused with an explanation or justification.
- i. Anticipated net cost savings determined by subtracting Contractor program management costs and the cost of disposal from the revenue generated by sale of the materials and the incineration and/or landfill cost avoidance.

The contractor shall notify the Contracting Officer if diversion activities will cause the project duration time to be exceeded. Along with the notification, the contractor shall provide the highest diversion rate that can be obtained based on the project schedule. If it is determined by the Government that the project is mission-critical, the diversion rate may be amended.

If the cost of achieving the fifty percent (50%) minimum diversion rate is significantly greater than the cost of conventional demolition methods and the risk can be attributed directly to meeting the minimum diversion rate, the contractor shall immediately notify the Contracting Officer for a determination on whether a lower diversion rate is acceptable. If the Contracting Officer determines that a lower diversion rate is acceptable, the rate may be amended to the highest obtainable rate that can be met as agreed upon by all parties.

6.19.6.4 RECORDS

Records shall be maintained to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. In addition to the reporting criteria contain herein, the Contractor shall refer to Appendix E ENVIRONMENTAL INFORMATION for specific reporting requirements. The records shall be made available to the Contracting Officer during construction, and a copy of the records shall be delivered to the Contracting Officer upon completion of the construction. Throughout the duration of the contract, contractor shall maintain and make available to the Contracting Officer, records, to include all weight tickets, documenting the quantity of waste generated, the quantity of waste diverted from a landfill

or incineration and the quantity of waste disposed by landfill or incineration. Upon contract completion, the contractor shall submit a copy of all records with a statement certifying that at least fifty percent (50%) of C&D waste has been diverted from landfill disposal to the Installation.

6.19.6.5 COLLECTION

The necessary containers, bins and storage areas to facilitate effective waste management shall be provided and shall be clearly and appropriately identified. Recyclable materials shall be handled to prevent contamination of materials from incompatible products and materials and separated by one of the following methods:

a) Source Separated Method.

Waste products and materials that are recyclable shall be separated from trash and sorted into appropriately marked separate containers and then transported to the respective recycling facility for further processing.

b) Co-Mingled Method.

Waste products and recyclable materials shall be placed into a single container and then transported to a recycling facility where the recyclable materials are sorted and processed.

c) Other Methods.

Other methods proposed by the Contractor may be used when approved by the Contracting Officer.

6.19.6.6 DISPOSAL

Except as otherwise specified in other sections of the specifications, disposal shall be in accordance with the following:

a) Reuse.

First consideration shall be given to salvage for reuse since little or no re-processing is necessary for this method, and less pollution is created when items are reused in their original form. Sale or donation of waste suitable for reuse shall be considered. Salvaged materials, other than those specified in other sections to be salvaged and reinstalled, shall not be used in this project.

b) Recycle.

Waste materials not suitable for reuse, but having value as being recyclable, shall be made available for recycling whenever economically feasible.

c) Waste.

Materials with no practical use or economic benefit shall be disposed at a landfill or incinerator.

6.19.7 STRUCTURAL INTERIOR DESIGN (SID) REQUIREMENTS

6.19.7.5 GENERAL INFORMATION

Structural Interior Design includes all building related elements and components generally part of the building itself, such as wall finishes, ceilings finishes, floor coverings, marker/bulletin boards, blinds, signage and built in casework. The SID should be developed in conjunction with the furniture footprint.

6.19.7.6 STRUCTURAL INTERIOR DESIGN (SID) REQUIREMENTS FOR THE INTERIM AND FINAL DESIGN SUBMITTALS

a) FORMAT AND SCHEDULE

1. Prepare and submit for approval an interior and exterior building finishes scheme for an interim design submittal. The DOR shall meet with and discuss the finish schemes with the appropriate Government officials prior to preparation of the schemes to be presented. Present original sets of the schemes to reviewers at an interim design conference.
2. At the conclusion of the interim phase, after resolutions to the comments have been agreed upon between DOR and Government reviewers, the DB Contractor may proceed to final design with the interior finishes scheme presented.
3. The SID information and samples are to be submitted in 8 ½" x 11" format using three ring binders with pockets on the inside of the cover. When there are numerous pages with thick samples, use more than one binder. Large D-ring binders are preferred to O-ring binders. Use page protectors that are strong enough to keep pages from tearing out. Anchor large or heavy samples with mechanical fasteners, Velcro, or double-faced foam tape rather than rubber cement or glue. Fold out items must have a maximum spread of 25 ½". Provide cover and spines inserts sheets identifying the document as "Structural Interior Design" package and include the project title and location, project number, Contractor/A/E name and phone number(s), submittal stage and date.
4. The design submittal requirements will include, but are not limited to:
 - a. Narrative of the Structural Interior Design Objectives - The SID shall include a narrative that discusses the building related finishes. Include topics that relate to base standards, life safety, sustainable design issues, aesthetics, durability and maintainability, discuss the development and features as they relate to the occupants requirements and the building design.
 - b. Interior Color Boards - Each item on the color boards shall be identified and keyed to the contract documents to provide a clear indication of how and where each item will be used. To the maximum extent possible, finish samples shall be arranged by room type in order to illustrate room color coordination. All samples shall be labeled on the color boards with the manufacturer's name, patterns and colors name and number. Samples shall also be keyed or coded to match key code system used on contract drawings.
 - c. Material and finish samples shall indicate true pattern, color and texture. Photographs or colored photocopies of materials or fabrics to show large overall patterns are required in conjunction with actual samples to show the actual colors. Finish samples must be large enough to show a complete pattern or design where practical.
 - d. Interior Color boards shall include but not be limited to original color samples of the following:
 - i. All walls finishes, ceiling finishes, including information regarding tile patterns.
 - ii. All flooring finishes, including information regarding tile patterns.
 - iii. All signage, wall base, toilet partitions, operable/folding partitions and trim
 - iv. All millwork materials and finishes (cabinets, counter tops, etc.)
 - v. All window treatments (sills, blinds, etc.)
 - e. Exterior Color Boards - Prepare exterior finishes color boards in similar format as the interior finishes color boards, for presentation to the reviewers during an interim design conference. The exterior finishes boards shall include original color samples of all exterior finishes including but not limited to the following:
 - i. All Roof Finishes
 - ii. All Brick and cast stone Samples
 - iii. All Exterior Insulation and Finish Samples
 - iv. All Glass Color Samples

- v. All Exterior Metals Finishes
 - vi. All Window & Door Frame Finishes
 - vii. All Specialty Item Finishes, including trim
 - viii. Identify each item on the exterior finishes color boards and key to the building elevations to provide a clear indication of how and where each item will be used.
 - f. Color board samples shall reflect all actual finish textures, patterns and colors required as specified. Patterned samples shall be of sufficient size to adequately show pattern and its repeat if a repeat occurs.
- b) STRUCTURAL INTERIOR DESIGN DOCUMENTS
- 1. General - Structural interior design related drawings must indicate the placement of extents of SID material finishes and colors and must be sufficiently detailed to define all interior work. The following is a list of minimum requirements:
 - 2. Finish Color Schedule - Provide finish color schedule(s) in the contract documents. Provide a finish code, material type, manufacturer, series, and color designations.
 - 3. Interior Finish Plans - Indicate wall and floor patterns and color placement, material transitions and extents of interior finishes.
 - 4. Furniture Footprint Plans - Provide furniture footprint plans showing the outline of all freestanding and systems furniture for coordination of all other disciplines.
 - 5. Interior Signage - Include interior signage plans or schedules showing location and quantities of all interior signage. Key each interior sign to a quantitative list indicating size, quantity of each type and signage text.
 - 6. Interior Elevations, Sections and Details - Interior Elevations, Sections and Details: Indicate material, color and finish placement.

6.19.8 FURNITURE, FIXTURES & EQUIPMENT (FF&E) REQUIREMENTS

6.19.8.1 GENERAL INFORMATION

- a) FF&E is the selection, layout, specification and documentation of furniture includes but is not limited to workstations, seating, tables, storage and shelving, filing, trash receptacles, clocks, framed artwork, artificial plants, and other accessories. Contract documentation is required to facilitate pricing, procurement and installation. The FF&E package is based on the furniture footprint developed in the SID portion of the interior design. The FF&E package shall be developed concurrently with the building design to ensure that there is coordination between the furniture design, the electrical, IT and other building requirements.
- b) The DOR shall interview Government personnel to determine FF&E requirements for furniture and furnishings. Determine FF&E items and quantities by, but not limited to: (1) the number of personnel to occupy the building, (2) job functions and related furniture/office equipment to support the job function, (3) room functions, (4) rank and grade.
- c) Lastly, for all designs provided regardless of facility type, the DOR shall make every effort to implement all aspects of sustainability to the greatest extent possible for all the selections made in the FF&E package. This includes but is not limited to the selection of products that consider: Material Chemistry and Safety of Inputs (What chemicals are used in the construction of the selections?); Recyclability (Do the selections contain recycled content?); Disassembly (Can the selections be disassembled at the end of their useful life to recycle their materials?).
- d) The DOR is encouraged to make selections to the greatest extent possible of products that possess McDonough Braungart Design Chemistry (HYPERLINK "<http://www.mbdc.com>" MBDC) certification or other "third-

party” certified Cradle to Cradle program, Forest Stewardship Council (FSC) certification, GREENGAURD certification or similar “third-party” certified products consisting of low-emitting materials.

6.19.8.2 FF&E REQUIREMENTS FOR THE INTERIM AND FINAL DESIGN SUBMITTALS

a) FORMAT AND SCHEDULE

1. Prepare and submit for approval a comprehensive FF&E scheme for an interim design submittal. The DOR shall meet with and discuss the FF&E scheme with the appropriate Government representatives prior to preparation of the scheme to be presented to discuss the intent of the overall design with regard to all the aspects of the FF&E design listed in paragraph 2.1.1 Narrative of Interior Design Objectives below. Then, present original sets of the scheme to reviewers at an interim design conference in conjunction with the interim architectural design or three months prior to the submittal of the final FF&E package (whichever comes first).

2. At the conclusion of the interim phase, after resolutions to the comments have been agreed upon between DOR and Government reviewers, the DB Contractor may proceed to final design with the FF&E scheme presented.

3. A complete and final FF&E package must be submitted to the Government in conjunction with the 100% architectural design submittal or ten months prior to the contract completion date (whichever comes first) to ensure adequate time for furniture acquisition.

4. The FF&E information and samples are to be submitted in 8 ½” x 11” format using three ring binders with pockets on the inside of the cover. When there are numerous pages with thick samples, use more than one binder. Large D-ring binders are preferred to O-ring binders. Use page protectors that are strong enough to keep pages from tearing out. Anchor large or heavy samples with mechanical fasteners, Velcro, or double-faced foam tape rather than rubber cement or glue. Fold out items must have a maximum spread of 25 ½”. Provide cover and spine inserts sheets identifying the document as “Furniture, Fixtures & Equipment” package and include the project title and location, project number, Contractor/A/E name and phone number(s), submittal stage and date.

5. The design submittal requirements will include, but are not limited to:

a. Narrative of Interior Design Objectives - Provide a narrative description of the furnishings design speaking to the selection of furnishings, finishes and colors. The narrative shall also include a discussion of the market research that resulted in the selection of a preferred vendor(s) items, including the sources that were considered and rejected, and why. Enumerate the design decisions made to fully coordinate the SID and the FF&E. Furthermore the narrative should include but not be limited to discussions on function, safety and ergonomics, durability, aesthetics, and all aspects of sustainability. Lastly, the narrative shall also include the written product description (item o. on the Furnishings Order Form) for each item to be procured in the FF&E package.

b. FF&E Procurement Listing - Provide a comprehensive listing of all the FF&E items with designation of whether each item will be procured as part of furnishings, equipment or the construction contract. The FF&E package shall be divided into sections based on this listing.

c. Point of Contacts - Provide a comprehensive list of Point of Contacts (POCs) needed to implement the FF&E project. This would include appropriate project team members, using activity contacts, interior design representatives, contractors and installers involved in the project. For each contact the name, company, job function, address, phone, fax and email.

d. Item Code Legend - Provide a consolidated list of all FF&E items in the design package with the item code and a short description of each item.

e. Item Installation List - The Item Code Legend may be expanded to be used as an Item installation List. Indicate quantity per room, model number, manufacturer and which vendor is responsible for installing each furnishings item.

f. Manufacturers Source List - Provide the Contractor's address, the ordering address, and the payment address including contact names, phone numbers, fax and email address. Also provide GSA contract information

including contract number, FSC group, part, section, expiration date, maximum order limit, pricing terms, shipping terms, etc.

g. Furnishings Order Forms - One Furnishings Order Form will be prepared for each item selected in the design. The goal is to provide this information on one page, however, if necessary, a second page may be used for additional detailed requirements. Each form shall identify all information required to procure each individual item. In addition to the project name and location, project number, and submittal phase, the order form must include:

- i. Furniture item illustration and code
- ii. Furniture item name
- iii. Job name, location, and date
- iv. General Services Administration (GSA) FSC Group, part, and section
- v. GSA Contract Number, Special Item Number (SIN), and contract expiration date
- vi. Maximum Order Limitation
- vii. GSA Contractor name (Include ordering and payment address, telephone number & fax number, e-mail or website)
- viii. Manufacturer's name (Include address, telephone number & fax number) or indicate if same as GSA Contractor
- ix. Dealership/Installer name (include address, telephone number, fax number and point of contact name)
- x. Product name
- xi. Product model number or National Stock Number (NSN)
- xii. Finish name and number (code to finish samples)
- xiii. Fabric name and number, minimum Wyzenbeek Abrasion Test double rubs (code to fabric samples)
- xiv. Dimensions
- xv. Written Product Description: include a non-proprietary paragraph listing the salient features of the item to include but not limited to:
 - required features and characteristics
 - ergonomic requirements
 - functional requirements
 - testing requirements
 - furniture style
 - construction materials
 - minimum warranty

(Example: "These guest chairs are coordinated to match the task seating at each workstation. The size of the guest chair is critical because of the limited space where they are to be placed. If this company is not selected, coordinate the newly proposed finishes with furniture item numbers #001, 002, 003.")

- xvi. Item location by room number
 - xvii. Quantity per room
 - xviii. Total quantity
 - xix. Special instructions for procurement ordering and/or installation (if applicable)
 - xx. In addition to the preferred selected item, list two additional manufacturers' products that meet the requirements of the written product description. Information provided for each of the two additional manufacturer's products selected shall include manufacturer name address and telephone number, product series, product name and any other pertinent information necessary for their procurement.
- h. Color Boards - Color boards shall be provided for all finishes and fabrics for all FF&E items. Finishes to be included but not limited to paint, laminate, wood finish, fabric, etc.
- i. Itemized Furniture Cost Estimate - Provide an itemized cost estimate of furnishings keyed to the plans and specifications of products included in the package. This cost estimate should be based on GSA price schedules. The cost estimate must include separate line items for general contingency, installation, electrical hook-up for systems furniture or other furniture requiring hardwiring by a licensed electrician, freight charges and any other related costs. Installation and freight quotes from vendors should be use in lieu of a percentage allowance when available.
- b) INTERIOR DESIGN DOCUMENTS
1. Overall Furniture and Area Plans - Provide floor Plans showing locations and quantities of all freestanding, and workstation furniture proposed for each floor of the building. Key each room to a large scale Furniture Placement Plan showing the furniture configuration, of all furniture. Provide enlarged area plans with a key plan identifying the area in which the building is located. All the items on the drawings should be keyed by furniture item code.
2. Workstation Plans - Provide plans showing each typical workstation configuration in plan view, elevations or isometric view. Drawings shall illustrate panels and all major components for each typical workstation configuration. Workstations shall be identified using the same numbering system as shown on the project drawings. Components shall be keyed to a legend on each sheet which identifies and describes the components along with dimensions. To facilitate review the plan, elevations and isometric of each typical workstation shall appear together on a drawing sheet.
3. Panel Plans - Provide plans showing panel locations and critical dimensions from finished face of walls, columns, panels including clearances and aisle widths. Assemblies shall be keyed to a legend which shall include width, height, configuration and composition of frames, covers finishes, and fabrics, (if different selections exist within a project), power or non-powered connectors and wall mount hardware.
4. Electrical and Telecommunication Plans - Provide plans showing power provisions including type and locations of feeder components, activated outlets and other electrical components. Include on the plans locations and quantities of outlets for workstations. Clearly identify different outlets, i.e. electrical, LAN and telecommunication receptacles indicating each type proposed. Show wiring configuration, (circuiting, switching, internal and external connections) and provide as applicable.
5. Artwork Placement Plans - Provide an Artwork Placement Plan to show location of artwork, assign an artwork item code to each piece of artwork. As an alternative, artwork can be located on the Furniture Plans. Provide a schedule that identifies each piece by room name and number. Provide installation instructions; include mounting height.
6. Window Drapery Plans - Provide Interior Window Drapery Plans. Key each drapery treatment to a schedule showing color, pattern, material, drapery size and type, draw direction, location and quantities.

c) ELECTRONIC DOCUMENTS (Not Required for Interim Submittal)

1. Upon completion of the corrected final submittal, provide five compact disks with electronic versions of all FF&E documents. Provide all drawings files in the latest release of AutoCAD. Provide all files needed to view complete drawings. These drawing files shall not be bound.

2. Provide all text documents in Microsoft Word and/or Excel.

6.19.9 FORT EUSTIS REQUIREMENTS FOR CAD AND HARD COPY DRAWINGS

6.19.9.1 Use National Cad Standard, A/E/C CADD Standard Release 3.0 dated September 2006.

6.19.9.2 Hard Copy requirements:

Mylars are required for all as-built drawings.

9.19.9.3. CD requirements:

(a) Label CD using a label maker. See 8. CD Label Requirements. The top portion of the label shows the layout and the information required. The bottom portion is an example of a cd label.

(b) CD of all as-built drawings is required.

(c) Cost estimates are to be on a separate CD from CD with drawings.

(d) The CD that contains drawings shall have the following subdirectories and files:

cad - dwg files of every mylar drawing.

pdf - pdf files of every mylar drawing.

cal - cal files of every mylar drawing.

cal files are required only for Corps of Engineers projects.

basis of design – files related to basis of design.

6.19.9.4. Title Blocks:

(a) Fort Eustis will supply title block drawings for DPW Design Projects. Insert title block drawings as a block. DPW title block drawings have attributes. Do not explode the title block drawings.

(b) Corps of Engineers will supply title block drawings for their Design Projects.

6.19.9.5. Drawing Index Sheet:

An index sheet is required for each set of drawings. Include the following on the index sheet for each drawing that makes up the set.

1. three digit sequential number starting with 001

2. sheet number

3. sheet name

6.19.9.6. Electronic CAD files names:

(a) See the National Cad Standard; A/E/C CADD Standard Release 3.0 dated September 2006 starting on page 6 for file name requirements.

- (b) A 20 character project code field shall be used as part of the electronic file name for ready-to-plot files and all other files that make up a set of drawings.
- (c) Ready-to-plot files – these drawings are listed on the index sheet.
- (d) Ready-to-plot electronic file names shall start with a three digit sequential number starting with 001, followed by an underscore, followed by the last four digits of the Fort Eustis drawing number, followed by an underscore, followed by a 10 digit project number, followed by an X or X's to complete the 20 character project code.
- (e) All other files - can be defined as reference and block files.
- (f) All other electronic file names shall start with XXX, followed by an underscore, followed by the last four digits of the Fort Eustis drawing number, followed by an underscore, followed by a 10 digit project number, followed by an X or X's to complete the 20 character project code.
- (g) The drawing number and project number shall be assigned to each set of drawings by Fort Eustis.
- (h) The drawing number assigned to the project by Fort Eustis shall be on every drawing, the drawing number is the same for each sheet.
- (i) Use the same ready-to-plot .dwg file names for the pdf & cal files.

6.19.9.7. Misc. Requirements:

- (a) All mylar drawings and cd drawings shall match each other.
- (b) If a revision occurs after a mylar is submitted, a revised mylar drawing shall be resubmitted to replace the old mylar.
- (c) If a revision occurs to a drawing after a cd is submitted, a cd with all current drawings for the project shall be resubmitted to replace the old cd.
- (d) use the insertion point of 0,0 for all reference files.

6.19.9.8. CD Label Requirements:

See Appendix DD for examples of CD Labels.

End of Section 01 10 00.0006

**SECTION 01 33 00.0006
SUBMITTAL PROCEDURES
(DESIGN-BUILD TASK ORDERS)**

1.0 GENERAL

1.13. GOVERNMENT APPROVED OR CONCURRED WITH SUBMITTALS

1.14. INFORMATION ONLY SUBMITTALS

1.0 GENERAL

1.1.1. This section contains requirements specifically applicable to this task order. The requirements of Base ID/IQ contract Section 01 33 30 apply to this task order, except as otherwise specified herein.

1.13. GOVERNMENT APPROVED OR CONCURRED WITH SUBMITTALS

Upon completion of review of submittals requiring Government approval or concurrence, the Government will stamp and date the submittals as approved or concurred. The Government will retain one (1) copies of the submittal and return one (1) copy(ies) of the submittal.

1.14. INFORMATION ONLY SUBMITTALS

Normally submittals for information only will not be returned. Approval of the Contracting Officer is not required on information only submittals. The Government reserves the right to require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or for check testing by the Government in those instances where the technical specifications so prescribe. The Government will retain zero(0) copies of information only submittals.

End of Section 01 33 00.0006

**SECTION 01 33 16
DESIGN AFTER AWARD**

1.0 GENERAL INFORMATION

1.1. INTRODUCTION

1.2. DESIGNER OF RECORD

2.0 PRODUCTS (Not Applicable)

3.0 EXECUTION

3.1. PRE-WORK ACTIVITIES & CONFERENCES

3.1.1. Design Quality Control Plan

3.1.2. Post Award Conference

3.1.3. Partnering & Project Progress Processes

3.1.4. Initial Design Conference

3.1.5. Pre-Construction Conference

3.2. STAGES OF DESIGN SUBMITTALS AND OVER THE SHOULDER PROGRESS REVIEWS

3.2.1. Site/Utilities

3.2.2. Interim Design Submittals

3.2.3. Over-the-Shoulder Progress Reviews

3.2.4. Final Design Submissions

3.2.5. Design Complete Submittals

3.2.6. Holiday Periods for Government Review or Actions

3.2.7. Late Submittals and Reviews

3.3. DESIGN CONFIGURATION MANAGEMENT

3.3.1. Procedures

3.3.2. Tracking Design Review Comments

3.3.3. Design and Code Checklists

3.4. INTERIM DESIGN REVIEWS AND CONFERENCES

3.4.1. General

3.4.2. Procedures

3.4.3. Conference Documentation

3.5. INTERIM DESIGN REQUIREMENTS

3.5.1. Drawings

3.5.2. Design Analyses

3.5.3. Geotechnical Investigations and Reports

3.5.4. LEED Documentation

3.5.5. Energy Conservation

3.5.6. Specifications

3.5.7. Building Rendering

3.5.8. Interim Building Design Contents

3.6. FINAL DESIGN REVIEWS AND CONFERENCES**3.7. FINAL DESIGN REQUIREMENTS**

3.7.1. Drawings

3.7.2. Design Analysis

3.7.3. Specifications

3.7.4. Submittal Register

3.7.5. Preparation of DD Form 1354 (Transfer of Real Property)

3.7.6. Acceptance and Release for Construction

3.8. DESIGN COMPLETE CONSTRUCTION DOCUMENT REQUIREMENTS**3.9. SUBMITTAL DISTRIBUTION, MEDIA AND QUANTITIES**

3.9.1. Submittal Distribution and Quantities

3.9.2. Web based Design Submittals

3.9.3. Mailing of Design Submittals

3.10. AS-BUILT DOCUMENTS**ATTACHMENT A STRUCTURAL INTERIOR DESIGN (SID) REQUIREMENTS****ATTACHMENT B FURNITURE, FIXTURES AND EQUIPMENT REQUIREMENTS****ATTACHMENT C TRACKING COMMENTS IN DRCHECKS****ATTACHMENT D SAMPLE FIRE PROTECTION AND LIFE SAFETY CODE REVIEW****ATTACHMENT E LEED SUBMITTALS****ATTACHMENT F BUILDING INFORMATION MODELING REQUIREMENTS**

ATTACHMENT G DESIGN SUBMITTAL DIRECTORY AND SUBDIRECTORY FILE ARRANGEMENT

1.0 GENERAL INFORMATION

1.1. INTRODUCTION

1.1.1. The information contained in this section applies to the design required after award. After award, the Contractor will develop the accepted proposal into the completed design, as described herein.

1.1.2. The Contractor may elect to fast track the design and construction that is, proceed with construction of parts of the sitework and facilities prior to completion of the overall design. To facilitate fast tracking, the Contractor may elect to divide the design into no more than ten (10) design packages per major facility type and no more than three (3) design packages for site and associated work. Designate how it will package the design, consistent with its overall plan for permitting (where applicable) and construction of the project. See Sections 01 33 00 SUBMITTAL PROCEDURES and 01 32 01.00 10 PROJECT SCHEDULE for requirements for identifying and scheduling the design packaging plan in the submittal register and project schedule. See also Sections 01 10 00 STATEMENT OF WORK and 01 57 20.00 10 ENVIRONMENTAL PROTECTION for any specified permit requirements. If early procurement of long-lead item construction materials or installed equipment, prior to completion of the associated design package, is necessary to facilitate the project schedule, also identify those long-lead items and how it will assure design integrity of the associated design package to meet the contract requirements (The Contract consists of the Solicitation requirements and the accepted proposal). Once the Government is satisfied that the long-lead items meet the contract requirements, the Contracting Officer will allow the Contractor to procure the items at its own risk.

1.1.3. The Contractor may proceed with the construction work included in a separate design package after the Government has reviewed the final (100%) design submission for that package, review comments have been addressed and resolved to the Government's satisfaction and the Contracting Officer (or the Administrative Contracting Officer) has agreed that the design package may be released for construction.

1.1.4. **INTEGRATED DESIGN.** To the maximum extent permitted for this project, use a collaborative, integrated design process for all stages of project delivery with comprehensive performance goals for siting, energy, water, materials and indoor environmental quality and ensures incorporation of these goals. Consider all stages of the building lifecycle, including deconstruction.

1.2. DESIGNER OF RECORD

Identify, for approval, the Designer of Record ("DOR") that will be responsible for each area of design. One DOR may be responsible for more than one area. Listed, Professional Registered, DOR(s) shall account for all areas of design disciplines shall be accounted for by a listed. The DOR's shall stamp, sign, and date each design drawing and other design deliverables under their responsible discipline at each design submittal stage (see contract clause Registration of Designers). If the deliverables are not ready for release for construction, identify them as "preliminary" or "not for release for construction" or by using some other appropriate designation. The DOR(s) shall also be responsible for maintaining the integrity of the design and for compliance with the contract requirements through construction and documentation of the as-built condition by coordination, review and approval of extensions of design, material, equipment and other construction submittals, review and approval or disapproval of requested deviations to the accepted design or to the contract, coordination with the Government of the above activities, and by performing other typical professional designer responsibilities.

2.0 PRODUCTS (Not Applicable)

3.0 EXECUTION

3.1. PRE-WORK ACTIVITIES & CONFERENCES

3.1.1. Design Quality Control Plan

Submit for Government acceptance, a Design Quality Control Plan in accordance with Section 01 45 04.00 10 CONTRACTOR QUALITY CONTROL before design may proceed.

3.1.2. Post Award Conference

3.1.2.1. The government will conduct a post award contract administration conference at the project site, as soon as possible after contract award. This will be coordinated with issuance of the contract notice to proceed (NTP). The Contractor and major sub-contractor representatives shall participate. All designers need not attend this first meeting. Government representatives will include COE project delivery team members, facility users, facility command representatives, and installation representatives. The Government will provide an agenda, meeting goals, meeting place, and meeting time to participants prior to the meeting.

3.1.2.2. The post award conference shall include determination and introduction of contact persons, their authorities, contract administration requirements, discussion of expected project progress processes, and coordination of subsequent meetings for quality control (see Section 01 45 04.00 10 CONTRACTOR QUALITY CONTROL), Partnering (see below and SCR: Partnering), and the initial design conference (see below).

3.1.2.3. The government will introduce COE project delivery team members, facility users, facility command representatives, and installation representatives. The DB Contractor shall introduce major subcontractors, and other needed staff. Expectations and duties of each person shall be defined for all participants. A meeting roster shall be developed and distributed by the government with complete contact information including name, office, project role, phone, mailing and physical address, and email address.

3.1.3. Partnering & Project Progress Processes

3.1.3.1. The initial Partnering conference may be scheduled and conducted at any time with or following the post award conference. The Government proposes to form a partnership with the DB Contractor to develop a cohesive building team. This partnership will involve the COE project delivery team members, facility users, facility command representatives, installation representatives, Designers of Record, major subcontractors, contractor quality control staff, and contractor construction management staff. This partnership will strive to develop a cooperative management team drawing on the strengths of each team member in an effort to achieve a quality project within budget and on schedule. This partnership will be bilateral in membership and participation will be totally voluntary. All costs, excluding labor and travel expenses, shall be shared equally between the Government and the Contractor. The Contractor and Government shall be responsible for their own labor and travel costs. Normally, partnering meetings will be held at or in the vicinity of the project installation.

3.1.3.2. As part of the partnering process, the Government and Contractor shall develop, establish, and agree to comprehensive design development processes including conduct of conferences, expectations of design development at conferences, fast-tracking, design acceptance, Structural Interior Design (SID)/ Furniture, Fixtures & Equipment (FF&E) design approval, project closeout, etc. The government will explain contract requirements and the DB Contractor shall review their proposed project schedule and suggest ways to streamline processes.

3.1.4. Initial Design Conference

The initial design conference may be scheduled and conducted at the project installation any time after the post award conference, although it is recommended that the partnering process be initiated with or before the initial design conference. Any design work conducted after award and prior to this conference should be limited to site and is discouraged for other items. All Designers of Record shall participate in the conference. The purpose of the meeting is to introduce everyone and to make sure any needs the contractor has are assigned and due dates established as well as who will get the information. See also Attachment F, BUILDING INFORMATION MODELING REQUIREMENTS for discussion concerning the BIM Implementation Plan demonstration at this meeting. The DB Contractor shall conduct the initial design conference.

3.1.5. Pre-Construction Conference

Before starting construction activities, the Contractor and Government will jointly conduct a pre-construction administrative conference to discuss any outstanding requirements and to review local installation requirements for start of construction. It is possible there will be multiple Pre-Construction Conferences based on the content of the design packages selected by the Contractor. The Government will provide minutes of this meeting to all participants.

3.2. STAGES OF DESIGN SUBMITTALS AND OVER THE SHOULDER PROGRESS REVIEWS

The stages of design submittals described below define Government expectations with respect to process and content. The Contractor shall determine how to best plan and execute the design and review process for this project, within the parameters listed below. As a minimum, the Government expects to see at least one interim design submittal, at least one final design submittal before construction of a design package may proceed and at least one Design Complete submittal that documents the accepted design. The Contractor may sub-divide the design into separate packages for each stage of design and may proceed with construction of a package after the Government accepts the final design for that package. See discussion on waivers to submission of one or more intermediate design packages where the parties partner during the design process. See also Attachment F, BUILDING INFORMATION MODELING REQUIREMENTS for discussion concerning BIM and the various stages of design submittals and over-the-shoulder progress reviews.

3.2.1. Site/Utilities

To facilitate fast-track design-construction activities the contractor may submit a final (100%) site and utility design as the first design submittal or it may elect to submit interim and final site and utility design submittals as explained below. Following review, resolution, and incorporation of all Government comments, and submittal of a satisfactory set of site/utility design documents, after completing all other pre-construction requirements in this contract and after the pre-construction meeting, the Government will allow the Contractor to proceed with site development activities, including demolition where applicable, within the parameters set forth in the accepted design submittal. For the first site and utility design submission, whether an interim or final, the submittal review, comment, and resolution times from this specification apply, except that the Contractor shall allow the Government a 14 calendar day review period, exclusive of mailing time. No on-site construction activities shall begin prior to written Government clearance to proceed.

3.2.2. Interim Design Submittals

The Contractor may submit either a single interim design for review, representing a complete package with all design disciplines, or split the interim design into smaller, individual design packages as it deems necessary for fast-track construction purposes. As required in Section 01 32 01.00 10 PROJECT SCHEDULE, the Contractor shall schedule its design and construction packaging plan to meet the contract completion period. This submission is the Government's primary opportunity to review the design for conformance to the solicitation and to the accepted contract proposal and to the Building Codes at a point where required revisions may be still made, while minimizing lost design effort to keep the design on track with the contract requirements. The requirements for the interim design review submittals and review conferences are described hereinafter. This is not necessarily a hold point for the design process; the Contractor may designate the interim design submittal(s) as a snapshot and proceed with design development at its own risk. See below for a waiver, where the parties establish an effective over-the-shoulder progress review procedure through the partnering process that would eliminate the need for or expedite a formal intermediate design review on one or more individual design packages.

3.2.3. Over-the-Shoulder Progress Reviews

To facilitate a streamlined design-build process, the Government and the Contractor may agree to one-on-one reviewer or small group reviews, electronically, on-line (if available within the Contractor's standard design practices) or at the Contractor's design offices or other agreed location, when practicable to the parties. The Government and Contractor will coordinate such reviews to minimize or eliminate disruptions to the design process. Any data required for these reviews shall normally be provided in electronic format, rather than in hard copy. If the Government and Contractor establish and implement an effective, mutually agreeable partnering procedure for regular (e.g., weekly) over-the-shoulder review procedures that allow the Government reviewers the opportunity to keep fully informed of the progress, contents, design intent, design documentation, etc. of the design package, the Government will agree to waive or to expedite the formal intermediate design review period for that package. The Contractor shall still be required to submit the required intermediate design documentation, however the parties may agree to how that material will be provided, in lieu of a formal consolidated submission of the package. It should be noted that Government funding is extremely limited for non-local travel by design reviewers, so the maximum use of virtual teaming methods must be used. Some possible examples include electronic file sharing, interactive software with on-line or telephonic conferencing, televideo conferencing, etc. The Government must still perform its Code and Contract conformance reviews, so the Contractor is encouraged to partner with the reviewers to find ways to facilitate this process and to facilitate meeting or bettering the design-build schedule. The Contractor shall maintain a fully functional configuration management system as described herein to track design revisions, regardless of whether or not there is a need for a formal intermediate design review. The formal intermediate

review procedures shall form the contractual basis for the official schedule, in the event that the partnering process determines that the formal intermediate review process to be best suited for efficient project execution. However, the Government pledges to support and promote the partnering process to work with the Contractor to find ways to better the design schedule.

3.2.4. Final Design Submissions

This submittal is required for each design package prior to Government acceptance of that design package for construction. The requirements for the final design submittal review conferences and the Government's acceptance for start of construction are described herein after.

3.2.5. Design Complete Submittals

After the final design submission and review conference for a design package, revise the design package to incorporate the comments generated and resolved in the final review conferences, perform and document a back-check review and submit the final, design complete documents, which shall represent released for construction documents. The requirements for the design complete submittals are described hereinafter.

3.2.6. Holiday Periods for Government Review or Actions

Do not schedule meetings, Government reviews or responses during the last two weeks of December or other designated Government Holidays (including Friday after Thanksgiving). Exclude such dates and periods from any durations specified herein for Government actions.

3.2.7. Late Submittals and Reviews

If the Contractor cannot meet its scheduled submittal date for a design package, it must revise the proposed submittal date and notify the government in writing, at least one (1) week prior to the submittal, in order to accommodate the Government reviewers' other scheduled activities. If a design submittal is over one (1) day late in accordance with the latest revised design schedule, or if notification of a proposed design schedule change is less than seven (7) days from the anticipated design submission receipt date, the Government review period may be extended up to seven (7) days due to reviewers' schedule conflicts. If the Government is late in meeting its review commitment and the delay increases the Contractor's cost or delays completion of the project, the Suspension of Work and Defaults clauses provide the respective remedy or relief for the delay.

3.3. DESIGN CONFIGURATION MANAGEMENT

3.3.1. Procedures

Develop and maintain effective, acceptable design configuration management (DCM) procedures to control and track all revisions to the design documents after the Interim Design Submission through submission of the As-Built documents. During the design process, this will facilitate and help streamline the design and review schedule. After the final design is accepted, this process provides control of and documents revisions to the accepted design (See Special Contract Requirement: Deviating From the Accepted Design). The system shall include appropriate authorities and concurrences to authorize revisions, including documentation as to why the revision must be made. The DCM data shall be available to the Government reviewers at all times. The Contractor may use its own internal system with interactive Government concurrences, where necessary or may use the Government's "DrChecks Design Review and Checking System" (see below and Attachment C).

3.3.2. Tracking Design Review Comments

Although the Contractor may use its own internal system for overall design configuration management, the Government and the Contractor shall use the DrChecks Design Review and Checking System to initiate, respond to, resolve and track Government design compliance review comments. This system may be useful for other data which needs to be interactive or otherwise available for shared use and retrieval. See Attachment C for details on how to establish an account and set-up the DrChecks system for use on the project.

3.3.3. Design and Code Checklists

Develop and complete various discipline-specific checklists to be used during the design and quality control of each submittal. Submit these completed checklists with each design submittal, as applicable, as part of the project documentation. See Section 01 45 04.00 10 Contractor Quality Control, Attachment D for a Sample Fire Protection and Life Safety Code review checklist and Attachment E for LEED SUBMITTALS.

3.4. INTERIM DESIGN REVIEWS AND CONFERENCES

3.4.1. General

At least one interim design submittal, review and review conference is required for each design package (except that, per paragraph 3.2.1, the Contractor may skip the interim design submission and proceed directly to final design on the sitework and utilities package). The DB Contractor may include additional interim design conferences or over-the-shoulder reviews, as needed, to assure continued government concurrence with the design work. Include the interim submittal review periods and conferences in the project schedule and indicate what part of the design work is at what percentage of completion. The required interim design conferences shall be held when interim design requirements are reached as described below. See also Paragraph: **Over-the-Shoulder Progress Reviews** for a waiver to the formal interim design review.

3.4.2. Procedures

After receipt of an Interim Design submission, allow the Government fourteen (14) calendar days after receipt of the submission to review and comment on the interim design submittal. For smaller design packages, especially those that involve only one or a few separate design disciplines, the parties may agree on a shorter review period or alternative review methods (e.g., over-the-shoulder or electronic file sharing), through the partnering process. For each interim design review submittal, the COR will furnish, to the Contractor, a single consolidated, validated listing of all comments from the various design sections and from other concerned agencies involved in the review process using the DrChecks Design Review and Checking System. The review will be for conformance with the technical requirements of the solicitation and the Contractor's RFP proposal. If the Contractor disagrees technically with any comment or comments and does not intend to comply with the comment, he/she must clearly outline, with ample justification, the reasons for noncompliance within five (5) days after receipt of these comments in order that the comment can be resolved. Furnish disposition of all comments, in writing, through DrChecks. The Contractor is cautioned that if it believes the action required by any comment exceeds the requirements of this contract, that it should take no action and notify the COR in writing immediately. The Interim Review conference will be held for each design submittal at the installation. Bring the personnel that developed the design submittal to the review conference. The conference will take place the week after the receipt of the comments by the Contractor. For smaller fast-track packages that involve only a few reviewers, the parties may agree to alternative conferencing methods, such as teleconferencing, or televideo, where available, as determined through Partnering.

3.4.3. Conference Documentation

3.4.3.1. In order to facilitate and accelerate the Government code and contract conformance reviews, identify, track resolution of and maintain all comments and action items generated during the design process and make this available to the designers and reviewers prior to the Interim and subsequent design reviews.

3.4.3.2. The DB Contractor shall prepare meeting minutes and enter final resolution of all comments into DrChecks. Copies of comments, annotated with comment action agreed on, will be made available to all parties before the conference adjourns. Unresolved problems will be resolved by immediate follow-on action at the end of conferences. Incorporate valid comments. The Government reserves the right to reject design document submittals if comments are significant. Participants shall determine if any comments are critical enough to require further design development prior to government concurrence. Participants shall also determine how to proceed in order to obtain government concurrence with the design work presented.

3.5. INTERIM DESIGN REQUIREMENTS

Interim design deliverables shall include drawings, specifications, and design analysis for the part of design that the Contractor considers ready for review.

3.5.1. Drawings

Include comments from any previous design conferences incorporated into the documents to provide an interim design for the "part" submitted.

3.5.2. Design Analyses

3.5.2.1. The designers of record shall prepare and present design analyses with calculations necessary to substantiate and support all design documents submitted. Address design substantiation required by the applicable codes and references and pay particular attention to the following listed items:

3.5.2.2. For parts including sitework, include site specific civil calculations.

3.5.2.3. For parts including structural work, include structural calculations.

- (a) Identify all loads to be used for design.
- (b) Describe the method of providing lateral stability for the structural system to meet seismic and wind load requirements. Include sufficient calculations to verify the adequacy of the method.
- (c) Provide calculations for all principal roof, floor, and foundation members and bracing and secondary members.
- (d) Provide complete seismic analyses for all building structural, mechanical, electrical, architectural, and building features as dictated by the seismic zone for which the facility is being constructed.
- (e) Computer generated calculations must identify the program name, source, and version. Provide input data, including loads, loading diagrams, node diagrams, and adequate documentation to illustrate the design. The schematic models used for input must show, as a minimum, nodes/joints, element/members, materials/properties, and all loadings, induced settlements/deflections, etc., and a list of load combinations. Include an output listing for maximum/minimum stresses/forces and deflections for each element and the reactions for each loading case and combination.
- (f) See also the Security (Anti-Terrorism) requirements below for members subject to Anti-Terrorist Force Protection (ATFP) and Progressive Collapse requirements.
- (g) Fully coordinate and integrate the overall structural design between two different or interfacing construction types, such as modular and stick-built or multistory, stacked modular construction. Provide substantiation of structural, consolidation/settlement analysis, etc., as applicable, through the interfaces.

3.5.2.4. For Security (Anti-Terrorism): Provide a design narrative and calculations where applicable, demonstrating compliance with each of the 22 standards in UFC 4-010-01, which includes Design of Buildings to Resist Progressive Collapse (use the most recent version of UFC 4-023-03, regardless of references to any specific version in UFC 4-010-01). Where sufficient standoff distance is not being provided, show calculations for blast resistance of the structural system and building envelope. Show complete calculations for members subjected to ATFP loads, e.g., support members of glazed items (jambs, headers, sills) connections of windows to support members and connections of support members to the rest of the structure. For 3 story and higher buildings, provide calculations to demonstrate compliance with progressive collapse requirements.

3.5.2.5. For parts including architectural work, include building floor area analysis.

3.5.2.6. For parts including mechanical work, include HVAC analysis and calculations. Include complete design calculations for mechanical systems. Include computations for sizing equipment, compressed air systems, air duct design, and U-factors for ceilings, roofs and exterior walls and floors. Contractor shall employ commercially available energy analysis techniques to determine the energy performance of all passive systems and features. Use of hourly energy load computer simulation is required (see paragraph 3.5.5.2 for list of acceptable software). Based on the results of calculations, provide a complete list of the materials and equipment proposed with the manufacturer's published cataloged product installation specifications and roughing-in data.

3.5.2.7. For parts including life safety, include building code analysis and sprinkler and other suppression systems. Notwithstanding the requirements of the Codes, address the following:

- (a) A registered fire protection engineer (FPE) must perform all fire protection analyses. Provide the fire protection engineer's qualifications. See Section 01 10 00, paragraph 5 for qualifications.

- (b) Provide all references used in the design including Government design documents and industry standards used to generate the fire protection analysis.
- (c) Provide classification of each building in accordance with fire zone, building floor areas and height and number of stories.
- (d) Provide discussion and description of required fire protection requirements including extinguishing equipment, detection equipment, alarm equipment and water supply. Alarm and detection equipment shall interface to requirements of Electronic Systems.
- (e) Provide hydraulic calculations based on water flow test for each sprinkler system to insure that flow and pressure requirements can be met with current water supply. Include copies of Contractor's water flow testing done to certify the available water source.

3.5.2.8. For parts including plumbing systems:

- (a) List all references used in the design.
- (b) Provide justification and brief description of the types of plumbing fixtures, piping materials and equipment proposed for use.
- (c) Detail calculations for systems such as sizing of domestic hot water heater and piping; natural gas piping; LP gas piping and tanks, fuel oil piping and tanks, etc., as applicable.
- (d) When the geotechnical report indicates expansive soils are present, indicate in the first piping design submittal how piping systems will be protected against damage or backfall/backflow due to soil heave (from penetration of slab to the 5 foot building line).

3.5.2.9. For elevator systems:

- (a) List all criteria codes, documents and design conditions used.
- (b) List any required permits and registrations for construction of items of special mechanical systems and equipment.

3.5.2.10. For parts including electrical work, include lighting calculations to determine maintained foot-candle levels, electrical load analysis and calculations, electrical short circuit and protective device coordination analysis and calculations and arc fault calculations.

3.5.2.11. For parts including telecommunications voice/data (including SIPRNET, where applicable), include analysis for determining the number and placement of outlets

3.5.2.12. For Cathodic Protection Systems, provide the following stamped report by the licensed corrosion engineer or NACE specialist with the first design submission. The designer must be qualified to engage in the practice of corrosion control of buried or submerged metallic surfaces. He/she must be accredited or certified by the National Association of Corrosion Engineers (NACE) as a NACE Accredited Corrosion Specialist or a NACE certified Cathodic Protection Specialist, or must be a registered professional engineer with a minimum of five years experience in corrosion control and cathodic protection. Clearly describe structures, systems or components in soil or water to be protected. Describe methods proposed for protection of each.

3.5.3. Geotechnical Investigations and Reports:

3.5.3.1. The contractor's licensed geotechnical engineer shall prepare a final geotechnical evaluation report, to be submitted along with the first foundation design submittal. Make this information available as early as possible during the over-the-shoulder progress review process. Summarize the subsurface conditions and provide recommendations for the design of appropriate utilities, foundations, floor slabs, retaining walls, embankments, and pavements. Include compaction requirements for fill and backfill under buildings, sidewalks, other structures and open areas. Recommend foundation systems to be used, allowable bearing pressures for footings, lateral load resistance capacities for foundation systems, elevations for footings, grade beams, slabs, etc. Provide an assessment of post-construction settlement potential including total and differential. Provide recommendations regarding lateral earth pressures (active, at-rest, passive) to be used in the design of retaining walls. Include the recommended spectral accelerations and Site Class for seismic design along with an evaluation of any seismic hazards and recommendations for mitigation, if required. Include calculations to support the recommendations for bearing capacity, settlement, and pavement sections. Include supporting documentation for all recommended

design parameters such as Site Class, shear strength, earth pressure coefficients, friction factors, subgrade modulus, California Bearing Ratio (CBR), etc. Provide earthwork recommendations, expected frost penetration, expected groundwater levels, recommendations for dewatering and groundwater control and the possible presence of any surface or subsurface features that may affect the construction of the project such as sinkholes, boulders, shallow rock, old fill, old structures, soft areas, or unusual soil conditions. Include pH tests, salinity tests, resistivity measurements, etc., required to design corrosion control and grounding systems. Include the raw field data. Arrange a meeting with the Government subsequent to completion and evaluation of the site specific geotechnical exploration to outline any differences encountered that are inconsistent with the Government provided preliminary soils information. Clearly outline differences which require changes in the foundation type, or pavement and earthwork requirements from that possible and contemplated using the Government furnished preliminary soils investigation, which result in a change to the design or construction. Any equitable adjustment is subject to the provisions of the contract's Differing Site Conditions Clause.

3.5.3.2. Vehicle Pavements: The Contractor's geotechnical report shall contain flexible and rigid pavement designs, as applicable for the project, including design CBR and modulus of subgrade reaction and the required compaction effort for subgrades and pavement layers. Provide Information on the types of base course materials available in the area and design strengths.

3.5.3.3. The Contractor and the professional geotechnical engineer consultant shall certify in writing that the design of the project has been developed consistent with the Contractor's final geotechnical report. The certification shall be stamped by the consulting professional geotechnical engineer and shall be submitted with the first design submission. If revisions are made to the initial design submission, a new certification shall be provided with the final design submission.

3.5.4. LEED Documentation:

Assign a LEED Accredited Professional, responsible to track LEED planning, performance and documentation for each LEED credit through construction closeout. Incorporate LEED credits in the plans, specifications and design analyses. Develop LEED supporting documentation as a separable portion of the Design Analysis and provide with each required design submittal. Include the LEED Project checklist for each non-exempt facility (one checklist may be provided for multiple facilities in accordance with the LEED-NC Application Guide for Multiple Buildings and On-Campus Building Projects and the LEED SUBMITTALS (Attachment E, herein) with each submittal. Final design submittal for each portion of the work must include all required design documentation relating to that portion of work (example - all site credit design documents with final site design). Submittal requirements are as indicated in Attachment E, LEED SUBMITTALS. Submit all documentation indicated on Attachment E as due at final design at final design submittal (for fast-track projects with multiple final design submittals, this shall be at the last scheduled final design submittal). All project documentation related to LEED shall conform to USGBC requirements for both content and format, including audit requirements and be separate from other design analyses. Maintain and update the LEED documentation throughout project progress to construction closeout and shall compile product data, receipts, calculations and other data necessary to substantiate and support all credits claimed. The Government may audit any or all individual credits. Audit documentation is not required to be submitted unless requested. These requirements apply to all projects. If the project requires the Contractor to obtain USGBC certification, the Contractor shall also be responsible for obtaining USGBC certification and shall provide written evidence of certification with the construction closeout LEED documentation submittal. Install the USGBC building plaque at the location indicated by the Government upon receipt. If Contractor obtains USGBC interim design review, submit the USGBC review to the Government within 30 days of receipt for information only.

3.5.4.1. LEED Documentation for Technology Solution Set. If the Solicitation provides a Prescriptive Technology Solution Set, use of the Technology Solution set has no effect on LEED documentation requirements. Provide all required LEED documentation, including energy analysis, in accordance with LEED requirements when using the Technology Solution Set.

3.5.5. Energy Conservation:

3.5.5.1. Refer to Section 01 10 00, Paragraph 5. Interim and Final Design submittals shall demonstrate that each building including the building envelope, HVAC systems, service water heating, power, and lighting systems meet the Mandatory Provisions and the Prescriptive Path requirements of ASHRAE 90.1. Use Compliance Documentation forms available from ASHRAE and included in the ASHRAE 90.1 User's Manual for this purpose. The Architectural Section of the Design Analysis shall include completed forms titled "Building Envelope

Compliance Documentation Parts I and II". The Heating Ventilating and Air Conditioning (HVAC) Section of the Design Analysis shall include a completed form titled "HVAC Simplified Approach Option - Part I" if this approach is allowed by the Standard. Otherwise, the HVAC Section of the Design Analysis shall include completed forms titled "HVAC Mandatory Provisions - Part II" and "HVAC Prescriptive Requirements - Part III". The Plumbing Section of the Design Analysis shall include a completed form titled "Service Water Heating Compliance Documentation". The Electrical Section of the Design Analysis shall include an explanatory statement on how the requirements of ASHRAE 90.1-2004 Chapter 8 Power were met. The Electrical Section of the Design Analysis shall also include a completed form titled "Lighting Compliance Documentation".

3.5.5.2. Interim and Final Design submittals which address energy consuming systems, (heating, cooling, service hot water, lighting, power, etc.) must also include calculations in a separate Energy Conservation Section of the Design Analysis which demonstrate and document (a) the baseline energy consumption for the facility or facilities under contract, that would meet the requirements of ANSI/ASHRAE/IESNA Standard 90.1 and (b) the energy consumption of the facility or facilities under contract utilizing the materials and methods required by this construction contract. Use the USGBC Energy and Atmosphere (EA) Credit 1 compliance template / form or an equivalently detailed form for documenting compliance with the energy reduction requirements. This template / form is titled PERFORMANCE RATING METHOD and is available when the project is registered for LEED. The calculation methodology used for this documentation and analysis shall follow the guidelines set forth in Appendix G of ASHRAE 90.1, with two exceptions: a) receptacle and process loads may be omitted from the calculation; and b) the definition of the terms in the formula for Percentage Improvement found in paragraph G1.2 are modified as follows: Baseline Building Performance shall mean the annual energy consumption calculated for a building design intended for use as a baseline for rating above standard design meeting the minimum requirements of the energy standard, and Proposed Building Performance shall mean annual energy consumption calculated for the proposed building design intended for construction. This calculation shall address all energy consuming systems in a single integrated methodology. Include laboratory fume hoods and kitchen ventilation loads in the energy calculation. They are not considered process loads. Individual calculations for heating, cooling, power, lighting, power, etc. systems will not be acceptable. The following building simulation software is acceptable for use in calculating building energy consumption: Hourly Analysis Program (HAP) by Carrier Corp., TRACE 700 by Trane Corp., DOE-2 by US Department of Energy, EnergyPlus by DOD/DOE.

3.5.6. Specifications

Specifications may be any one of the major, well known master guide specification sources (use only one source) such as MASTERSPEC from the American Institute of Architects, SPECTEXT from Construction Specification Institute or Unified Facility Guide Specifications (UFGS using MASTERFORMAT 2004 numbering system), etc. (including specifications from these sources). Manufacturers' product specifications, utilizing CSI's Manu-Spec, three part format may be used in conjunction with the selected specifications. The designers of record shall edit and expand the appropriate Specifications to insure that all project design requirements, current code requirements, and regulatory requirements are met. Specifications shall clearly identify, where appropriate, specific products chosen to meet the contract requirements (i.e., manufacturers' brand names and model numbers or similar product information).

3.5.7. Building Rendering

Present and provide a draft color computer, artist, or hand drawn rendering with the conceptual design submittal of the building exterior. Perspective renderings shall include a slightly overhead view of the entire building to encompass elevations and the roof configuration of the building. After Government review and acceptance, provide a final rendering, including the following:

Three (3) 18" x 24" color prints, framed and matted behind glass with project title underneath the print.

One (1) Image file (high resolution) in JPG format on CD for those in the submittal distribution list.

3.5.8. Interim Building Design Contents

The following list represents what the Government considers should be included in the overall completed design for a facility or project. It is not intended to limit the contractor from providing different or additional information as needed to support the design presented, including the require design analyses discussed above. As the Contractor develops individual design packages and submits them for Interim review, include as much of the applicable

information for an individual design package as is developed at the Interim design level for review purposes. These pieces shall be developed as the design progresses toward the design complete stage.

3.5.8.1. Lawn and Landscaping Irrigation System

3.5.8.2. Landscape, Planting and Turfing

3.5.8.3. Architectural

- (a) Design Narrative
- (b) Architectural Floor Plans, Typical Wall and Roof Sections, Elevations
- (c) Finish schedule
- (d) All required equipment
- (e) Special graphics requirements
- (f) Door and Window Schedules
- (g) Hardware sets using BHMA designations
- (h) Composite floor plan showing all pre-wired workstations
- (i) Structural Interior Design (SID) package: See ATTACHMENT A for specific requirements
- (j) Furniture, Fixtures & Equipment (FF&E) design package: See ATTACHMENT B for specific requirements

3.5.8.4. Structural Systems. Include:

- (a) Drawings showing principal members for roof and floor framing plans as applicable
- (b) Foundation plan showing main foundation elements where applicable
- (c) Typical sections for roof, floor, and foundation conditions

3.5.8.5. Plumbing Systems

- (a) Show locations and general arrangement of plumbing fixtures and major equipment
- (b) Plan and isometric riser diagrams of all areas including hot water, cold water, waste and vent piping. Include natural gas (and meter as required), (natural gas and meter as required), (LP gas), (fuel oil) and other specialty systems as applicable.
- (c) Include equipment and fixture connection schedules with descriptions, capacities, locations, connection sizes and other information as required

3.5.8.6. HVAC Systems

- (a) Mechanical Floor Plans: The floor plans shall show all principle architectural features of the building which will affect the mechanical design. The floor plans shall also show the following:
 - (1) Room designations.
 - (2) Mechanical legend and applicable notes.
 - (3) Location and size of all ductwork and piping.
 - (4) Location and capacity of all terminal units (i.e., registers, diffusers, grilles, hydronic baseboards).
 - (5) Pre-Fabricated Paint Spray Booth (where applicable to project scope)
 - (6) Paint Preparation Area (where applicable to project scope)
 - (7) Exhaust fans and specialized exhaust systems.
 - (8) Thermostat location.
 - (9) Location of heating/cooling plant (i.e., boiler, chiller, cooling tower, etc).
 - (10) Location of all air handling equipment.

- (11) Air balancing information.
- (12) Flue size and location.
- (13) Piping diagram for forced hot water system (if used).
- (b) Equipment Schedule: Provide complete equipment schedules. Include:
 - (1) Capacity
 - (2) Electrical characteristics
 - (3) Efficiency (if applicable)
 - (4) Manufacturer's name
 - (5) Optional features to be provided
 - (6) Physical size
 - (7) Minimum maintenance clearances
- (a) Details: Provide construction details, sections, elevations, etc., only where required for clarification of methods and materials of design.
- (b) HVAC Controls: Submit complete HVAC controls equipment schedules, sequences of operation, wiring and logic diagrams, Input/Output Tables, equipment schedules, and all associated information. See the Statement of Work for additional specific requirements.

3.5.8.7. Fire Protection and Life Safety.

- (a) Provide plan for each floor of each building that presents a compendium of the total fire protection features being incorporated into the design. Include the following types of information:
 - (1) The location and rating of any fire-resistive construction such as occupancy separations, area separations, exterior walls, shaft enclosures, corridors, stair enclosures, exit passageways, etc.
 - (2) The location and coverage of any fire detection systems
 - (3) The location and coverage of any fire suppression systems (sprinkler risers, standpipes, etc.)
 - (4) The location of any other major fire protection equipment
 - (5) Indicate any hazardous areas and their classification
 - (6) Schedule describing the internal systems with the following information: fire hazard and occupancy classifications, building construction type, GPM/square foot sprinkler density, area of operation and other as required
- (b) Working plans and all other materials submitted shall meet NFPA 13 requirements, with respect to required minimum level of detail.

3.5.8.8. Elevators. Provide:

- (a) Description of the proposed control system
- (b) Description, approximate capacity and location of any special mechanical equipment for elevators.

3.5.8.9. Electrical Systems.

- (a) Electrical Floor Plan(s): Show all principle architectural features of the building which will affect the electrical design. Show the following:
 - (1) Room designations.
 - (2) Electrical legend and applicable notes.
 - (3) Lighting fixtures, properly identified.
 - (4) Switches for control of lighting.
 - (5) Receptacles.

- (6) Location and designation of panelboards. Clearly indicate type of mounting required (flush or surface) and reflect accordingly in specifications.
- (7) Service entrance (conduit and main disconnect).
- (8) Location, designation and rating of motors and/or equipment which requires electrical service. Show method of termination and/or connection to motors and/or equipment. Show necessary junction boxes, disconnects, controllers (approximate only), conduit stubs, and receptacles required to serve the motor and/or equipment.
- (b) Building Riser Diagram(s) (from pad-mounted transformer to unit load center panelboard): Indicate the types and sizes of electrical equipment and wiring. Include grounding and metering requirements.
- (c) Load Center Panelboard Schedule(s): Indicate the following information:
 - (1) Panelboard Characteristics (Panel Designation, Voltage, Phase, Wires, Main Breaker Rating and Mounting.
 - (2) Branch Circuit Designations.
 - (3) Load Designations.
 - (4) Circuit Breaker Characteristics. (Number of Poles, Trip Rating, AIC Rating)
 - (5) Branch Circuit Connected Loads (AMPS).
 - (6) Special Features
- (d) Lighting Fixture Schedule(s): Indicate the following information:
 - (1) Fixture Designation.
 - (2) General Fixture Description.
 - (3) Number and Type of Lamp(s).
 - (4) Type of Mounting.
 - (5) Special Features.
- (e) Details: Provide construction details, sections, elevations, etc. only where required for clarification of methods and materials of design.

3.5.8.10. Electronic Systems including the following responsibilities:

- (a) Fire Detection and Alarm System. Design shall include layout drawings for all devices and a riser diagram showing the control panel, annunciator panel, all zones, radio transmitter and interfaces to other systems (HVAC, sprinkler, etc.)
- (b) Fire Suppression System Control. Specify all components of the Fire Suppression (FS) System in the FS section of the specifications. Clearly describe how the system will operate and interact with other systems such as the fire alarm system. Include a riser diagram on the drawings showing principal components and interconnections with other systems. Include FS system components on drawing legend. Designate all components shown on floor plans "FS system components" (as opposed to "Fire Alarm components"). Show location of FS control panels, HVAC control devices, sensors, and 120V power panel connections on floor plans. Indicate zoning of areas by numbers (1, 2, 3) and detectors sub-zoned for cross zoning by letter designations (A and B). Differentiate between ceiling mounted and under floor detectors with distinct symbols and indicate sub-zone of each.
- (c) Public Address System
- (d) Special Grounding Systems. Completely reflect all design requirements in the specifications and drawings. Specifications shall require field tests (in the construction phase), witnessed by the Government, to determine the effectiveness of the grounding system. Include drawings showing existing construction, if any.
- (e) Cathodic Protection.
- (f) Intrusion Detection, Card Access System
- (g) Central Control and Monitoring System
- (h) Mass Notification System
- (i) Electrical Power Distribution Systems

3.5.8.11. Information Systems including the following responsibilities:

- (a) Telecommunications Cabling
- (b) Supporting Infrastructure
- (a) Outside Plant (OSP) Cabling - Campus or Site Plans - Exterior Pathways and Inter-Building Backbones
 - (a) Include a layout of the voice/data outlets (including voice only wall & pay phones) on telecommunication floor plan drawing, location of SIPRNET data outlets (where applicable), and a legend and symbol definition to indicate height above finished floor. Show size of conduit and cable type and size on Riser Diagram. Do not show conduit runs between backboard and outlets on the floor plans. Show underground distribution conduit and cable with sizing from point of presence to entrance facility of building.
 - (b) Layout of complete building per floor - Serving Zone Boundaries, Backbone Systems, and Horizontal Pathways including Serving Zones Drawings - Drop Locations and Cable ID's
 - (c) Communication Equipment Rooms - Plan Views - Tech and AMEP/Elevations - Racks and Walls. Elevations with a detailed look at all telecom rooms. Indicate technology layout (racks, ladder-racks, etc.), mechanical/electrical layout, rack elevation and backboard elevation. They may also be an enlargement of a congested area of T1 or T2 series drawing.

3.6. FINAL DESIGN REVIEWS AND CONFERENCES

A final design review and review conference will be held upon completion of final design at the project installation, or – where equipment is available - by video teleconference or a combination thereof, for any design package to receive Government acceptance to allow release of the design package for construction. For smaller separate design packages, the parties may agree on alternative reviews and conferences (e.g., conference calls and electronic file sharing, etc.) through the Partnering process. Include the final design conference in the project schedule and shall indicate what part of the design work is at 100% completion. The final design conference will be held after the Government has had seven (7) calendar days after receipt of the submission to review the final design package and supporting data. For smaller packages, especially those involving only one or a few design disciplines the parties may agree on a shorter period.

3.7. FINAL DESIGN REQUIREMENTS

Final design deliverables for a design package shall consist of 100% complete drawings, specifications, submittal register and design analyses for Government review and acceptance. The 100% design submission shall consist of drawings, specifications, updated design analyses and any permits required by the contract for each package submitted. In order to expedite the final design review, prior to the conference, ensure that the design configuration management data and all review comment resolutions are up-to-date. Include the 100% SID and 100% FF&E binders for government approval. The Contractor shall have performed independent technical reviews (ITR's) and back-checks of previous comment resolutions, as required by Section 01 45 04.00 10 CONTRACTOR QUALITY CONTROL, including providing documentation thereof.

3.7.1. Drawings

3.7.1.1. Submit drawings complete with all contract requirements incorporated into the documents to provide a 100% design for each package submitted.

3.7.1.2. Prepare all drawings with the Computer-Aided Design and Drafting (CADD)/Computer-Aided Design (CAD) system, organized and easily referenced electronically, presenting complete construction information.

3.7.1.3. Drawings shall be complete. The Contractor is encouraged to utilize graphics, views, notes, and details which make the drawings easier to review or to construct but is also encouraged to keep such materials to those that are necessary.

3.7.1.4. Provide detail drawings that illustrate conformance with the contract. Include room finish schedules, corresponding color/finish/special items schedules, and exterior finish schedules that agree with the submitted SID binders.

3.7.1.5. The design documents shall be in compliance with the latest version of the A/E/C CADD Standard, available at <https://caddbim.usace.army.mil/CAD>. Use the approved vertical Corps of Engineers title blocks and borders on all drawings with the appropriate firm name included within the title block area.

3.7.1.6. CAD System and Building Information Modeling (BIM) (NOTE: If this is a Single Award or Multiple Award, Indefinite Delivery/Indefinite Quantity Contract, this information will be provided for each task order.)

All CAD files shall be fully compatible with AutoCAD 2000 or higher. Save all design CAD files as AutoCAD 2000 or higher files. All submitted BIM Models and associated Facility Data shall be fully compatible with Bentley BIM file format and the USACE Bentley BIM v8 Workspace.

(a) CAD Data Final File Format: During the design development capture geo-referenced coordinates of all changes made to the existing site (facility footprint, utility line installations and alterations, roads, parking areas, etc) as a result of this contract. There is no mandatory methodology for how the geo-referenced coordinates will be captured, however, Engineering and Construction Bulletin No. 2006-15, Subject: Standardizing Computer Aided Design (CAD) and Geographic Information Systems (GIS) Deliverables for all Military Design and Construction Projects identifies the format for final as-built drawings and data sets to be delivered to the government. Close-out requirements at the as-built stage; require final geo-referenced GIS Database of the new facility along with all exterior modifications. The Government will incorporate this data set into the Installation's GIS Masterplan or Enterprise GIS System. See also, Section 01 78 02.00 10 Closeout Submittals.

(b) Electronic Drawing Files: In addition to the native CAD design files, provide separate electronic drawing files (in editable CAD format and Adobe Acrobat PDF version 7.0 or higher) for each project drawing.

(c) Each file (both CAD and PDF) shall represent one complete drawing from the drawing set, including the date, submittal phase, and border. Each drawing file shall be completely independent of any data in any other file, including fonts and shapes not included with the basic CAD software program utilized. Drawing files with external references or special fonts are not acceptable. All displayed graphic elements on all levels of the drawing files shall be part of the project drawing image. The drawing files shall not contain any graphic element that is not part of the drawing image.

(d) Deliver BIM Model and associated Facility Data files in their native format. At a minimum, BIM files shall address major architecture design elements, major structural components, mechanical systems and electrical/communication distribution and elements as defined in Attachment F. See Attachment F for additional BIM requirements.

(e) Drawing Index: Provide an index of drawings sheet in CAD as part of the drawing set, and an electronic list in Microsoft Excel of all drawings on the CD. Include the electronic file name, the sheet reference number, the sheet number, and the sheet title, containing the data for each drawing.

(f) Hard Copies: Plot submitted hard copy drawings directly from the "electronic drawing files" and copy for quantities and sizes indicated in the distribution list at the end of this specification section. The Designers of Record shall stamp, sign and date original hard copy sheets as Released For Construction, and provide copies for distribution from this set.

3.7.2. Design Analyses

3.7.2.1. The designers of record shall update, finalize and present design analyses with calculations necessary to substantiate and support all design documents submitted.

3.7.2.2. The responsible DOR shall stamp, sign and date the design analysis. Identify the software used where, applicable (name, version, vendor). Generally, provide design analyses, individually, in an original (file copy) and one copy for the assigned government reviewer.

3.7.2.3. All disciplines review the LEED design analysis in conjunction with their discipline-specific design analysis; include a copy of the separable LEED design analysis in all design analysis submittals.

3.7.2.4. Do not combine multi-disciplined volumes of design-analysis, unless multiple copies are provided to facilitate multiple reviewers (one copy per each separate design analysis included in a volume).

3.7.3. Specifications

Specifications shall be 100% complete and in final form.

3.7.4. Submittal Register

Prepare and update the Submittal Register and submit it with the 100% design specifications (see Specification Section 01 33 00, SUBMITTAL PROCEDURES) with each design package. Include the required submittals for each specification section in a design package in the submittal register.

3.7.5. Preparation of DD Form 1354 (Transfer of Real Property)

This form itemizes the types, quantities and costs of various equipment and systems that comprise the project, for the purpose of transferring the new construction project from the Corps Construction Division to the Installation's inventory of real property. The Government will furnish the DB Contractor's design manager a DD Form 1354 checklist to use to produce a draft Form 1354. Submit the completed checklist and prepared draft Form DD 1354 with the 100% design in the Design Analysis. The Corps will use these documents to complete the final DD 1354 upon completion of construction.

3.7.6. Acceptance and Release for Construction

3.7.6.1. At the conclusion of the Final Design Review (after resolutions to the comments have been agreed upon between DOR and Government reviewers), the Contracting Officer or the ACO will accept the Final Design Submission for the design package in writing and allow construction to start for that design package. The Government may withhold acceptance until all major corrections have been made or if the final design submission requires so many corrections, even though minor, that it isn't considered acceptably complete.

3.7.6.2. Government review and acceptance of design submittals is for contract conformance only and shall not relieve the Contractor from responsibility to fully adhere to the requirements of the contract, including the Contractor's accepted contract proposal, or limit the Contractor's responsibility of design as prescribed under Special Contract Requirement: "Responsibility of the Contractor for Design" or limit the Government's rights under the terms of the contract. The Government reserves the right to rescind inadvertent acceptance of design submittals containing contract deviations not separately and expressly identified in the submittal for Government consideration and approval.

3.8. DESIGN COMPLETE CONSTRUCTION DOCUMENT REQUIREMENTS

After the Final Design Submission and Review Conference and after Government acceptance of the Final Design submission, revise the design documents for the design package to incorporate the comments generated and resolved in the final review conference, perform and document a back-check review and submit the final, design complete documents. Label the final design complete documents "FOR CONSTRUCTION" or use similar language. In addition to the final drawings and specifications, the following deliverables are required for distribution and field use. The deliverable includes all documentation and supporting design analysis in final form, as well as the final review comments, disposition and the back-check. As part of the quality assurance process, the Government may perform a back-check of the released for construction documentation. Promptly correct any errors or omissions found during the Government back-check. The Government may withhold retainage from progress payments for work or materials associated with a final design package until this submittal has been received and the Government determines that it is complete.

3.9. SUBMITTAL DISTRIBUTION, MEDIA AND QUANTITIES

3.9.1. Submittal Distribution and Quantities

General: The documents which the Contractor shall submit to the Government for each submittal are listed and generally described in preceding paragraphs in this Section. Provide copies of each design submittal and design substantiation as follows (NOTE: If this is a Single Award or Multiple Award, Indefinite Delivery/Indefinite Quantity Contract, this information will be provided for each task order):

Activity and Address	Drawing Size (Full Size) 24 x 36 Full Sets/ *Partial Sets	Design Analyses & Specs Full Sets/ *Partial Sets	Drawing Size (Half Size) 12 x 18 Full Sets/ *Partial Sets	Non-BIM Data CD-ROM or DVD as Necessary (PDF& .dwg)	Furniture Submittal (FFE)	Structural Interior Design Submittal	BIM Data DVD (Per Attach F)
Commander, U.S.Army Engineer District Norfolk	3/0	3/0	3/0	3	3	3	3
Commander, U.S.Army Engineer District, Center of Standardization Fort Worth	0/0	0/0	0/0	0	0	0	0
Installation	0/0	6/0	6/0	1	1	1	1
U.S.Army Corps of Engineers Construction Area Office	2/0	3/0	1/0	0	0	0	0
Information Systems Engineering Command (ISEC)	0/0	0/0	0/0	1	1 (Electronic only)	N/A	1
Other Offices	0/0	8/0	8/0	1	0	0	0

***NOTE: For partial sets of drawings, specifications and design analyses, see paragraph 3.9.3.3, below.**

****NOTE: When specified below in 3.9.2, furnish Installation copies of Drawings as paper copies, in lieu of the option to provide secure web-based submittals.**

3.9.2. Web based Design Submittals

Except for full or half-sized drawings for Installation personnel, as designated in the Table above, Web based design submittals will be acceptable as an alternative to the paper copies listed in the Table above, provided a single hard-copy PDF based record set is provided to the Contracting Officer for record purposes. Where the contract requires the Contractor to submit documents to permitting authorities, still provide those authorities paper copies (or in an alternate format where required by the authority). Web based design submittal information shall be provided with adequate security and availability to allow unlimited access those specifically authorized to Government reviewers while preventing unauthorized access or modification. File sizes must be of manageable size for reviewers to quickly download or open on their computers. As a minimum, drawings shall be full scale on American National Standards Institute (ANSI) D sheets (34" x 22"). In addition to the optional website, provide the BIM data submission on DVD to each activity and address noted above in paragraph 3.9.1 for each BIM submission required in Attachment F.

3.9.3. Mailing of Design Submittals

3.9.3.1. Mail all design submittals to the Government during design and construction, using an overnight mailing service. The Government will furnish the Contractor addresses where each copy shall be mailed to after award of the contract (or individual task order if this is an indefinite delivery/indefinite quantity, task order contract). Mail the submittals to four (4) different addresses. Assemble drawing sheets, specs, design analyses, etc. into individual sets; do not combine duplicate pages from individual sets so that the government has to assemble a set.

3.9.3.2. Each design submittal shall have a transmittal letter accompanying it indicating the date, design percentage, type of submittal, list of items submitted, transmittal number and point of contact with telephone number.

3.9.3.3. Provide partial sets of drawings, specifications, design analyses, etc., as designated in the Table in paragraph 3.9.1, to those reviewers who only need to review their applicable portions of the design, such as the various utilities. The details of which office receives what portion of the design documentation will be worked out after award.

3.10. AS-BUILT DOCUMENTS

Provide as-built drawings and specifications in accordance with Section 01 78 02.00 10, CLOSEOUT SUBMITTALS. Update LEED design phase documentation during construction as needed to reflect construction changes and advancing project completion status (example - Commissioning Plan updates during construction phase) and include updated LEED documentation in construction closeout submittal.

ATTACHMENT A STRUCTURAL INTERIOR DESIGN (SID) REQUIREMENTS

1.0 GENERAL INFORMATION

Structural Interior Design includes all building related elements and components generally part of the building itself, such as wall finishes, ceilings finishes, floor coverings, marker/bulletin boards, blinds, signage and built in casework. Develop the SID in conjunction with the furniture footprint.

2.0 STRUCTURAL INTERIOR DESIGN (SID) REQUIREMENTS FOR THE INTERIM AND FINAL DESIGN SUBMITTALS

2.1. FORMAT AND SCHEDULE

Prepare and submit for approval an interior and exterior building finishes scheme for an interim design submittal. The DOR shall meet with and discuss the finish schemes with the appropriate Government officials prior to preparation of the schemes to be presented. Present original sets of the schemes to reviewers at an interim design conference.

At the conclusion of the interim phase, after resolutions to the comments have been agreed upon between DOR and Government reviewers, the Contractor may proceed to final design with the interior finishes scheme presented.

The SID information and samples are to be submitted in 8 ½" x 11" format using three ring binders with pockets on the inside of the cover. When there are numerous pages with thick samples, use more than one binder. Large D-ring binders are preferred to O-ring binders. Use page protectors that are strong enough to keep pages from tearing out. Anchor large or heavy samples with mechanical fasteners, Velcro, or double-faced foam tape rather than rubber cement or glue. Fold out items must have a maximum spread of 25 ½". Provide cover and spine inserts sheets identifying the document as "Structural Interior Design" package. Include the project title and location, project number, Contractor/A/E name and phone number(s), submittal stage and date.

Design submittal requirements include, but are not limited to:

2.1.1. Narrative of the Structural Interior Design Objectives

The SID shall include a narrative that discusses the building related finishes. Include topics that relate to base standards, life safety, sustainable design issues, aesthetics, durability and maintainability, discuss the development and features as they relate to the occupants requirements and the building design.

2.1.2. Interior Color Boards

Identify and key each item on the color boards to the contract documents to provide a clear indication of how and where each item will be used. Arrange finish samples to the maximum extent possible by room type in order to illustrate room color coordination. Label all samples on the color boards with the manufacturer's name, patterns and colors name and number. Key or code samples to match key code system used on contract drawings.

Material and finish samples shall indicate true pattern, color and texture. Provide photographs or colored photocopies of materials or fabrics to show large overall patterns in conjunction with actual samples to show the actual colors. Finish samples must be large enough to show a complete pattern or design where practical.

Color boards shall include but not be limited to original color samples of the following:

All walls finishes and ceiling finishes, including corner guards, acrylic wainscoting and wall guards/chair rail finishes

All tile information, including tile grout color and tile patterns.

- All flooring finishes, including patterns.
- All door, door frame finishes and door hardware finishes
- All signage, wall base, toilet partitions, locker finishes and operable/folding partitions and trim

- All millwork materials and finishes (cabinets, counter tops, etc.)
- All window frame finishes and window treatments (sills, blinds, etc.)

Color board samples shall reflect all actual finish textures, patterns and colors required as specified. Patterned samples shall be of sufficient size to adequately show pattern and its repeat if a repeat occurs.

2.1.3. Exterior Color Boards

Prepare exterior finishes color boards in similar format as the interior finishes color boards, for presentation to the reviewers during an interim design conference. Provide original color samples of all exterior finishes including but not limited to the following:

- All Roof Finishes
- All Brick and Cast Stone Samples
- All Exterior Insulation and Finish Samples
- All Glass Color Samples
- All Exterior Metals Finishes
- All Window & Door Frame Finishes
- All Specialty Item Finishes, including trim

Identify each item on the exterior finishes color boards and key to the building elevations to provide a clear indication of how and where each item will be used.

2.2. STRUCTURAL INTERIOR DESIGN DOCUMENTS

2.2.1. General

Structural interior design related drawings must indicate the placement of extents of SID material, finishes and colors and must be sufficiently detailed to define all interior work. The following is a list of minimum requirements:

2.2.2. Finish Color Schedule

Provide finish color schedule(s) in the contract documents. Provide a finish code, material type, manufacturer, series, and color designations. Key the finish code to the color board samples and drawings.

2.2.3. Interior Finish Plans

Indicate wall and floor patterns and color placement, material transitions and extents of interior finishes.

2.2.4. Furniture Footprint Plans

Provide furniture footprint plans showing the outline of all freestanding and systems furniture for coordination of all other disciplines.

2.2.5. Interior Signage

Include interior signage plans or schedules showing location and quantities of all interior signage. Key each interior sign to a quantitative list indicating size, quantity of each type and signage text.

2.2.6. Interior Elevations, Sections and Details

Indicate material, color and finish placement.

**ATTACHMENT B
FURNITURE, FIXTURES & EQUIPMENT (FF&E) REQUIREMENTS**

1.0 FF&E REQUIREMENTS FOR THE INTERIM AND FINAL DESIGN SUBMITTALS

1.1. FORMAT AND SCHEDULE

Prepare and submit for approval a comprehensive FF&E scheme for an interim design submittal. The Contractor's interior designer, not a furniture dealer, shall develop the design. FF&E is the selection, layout, specification and documentation of furniture includes but is not limited to workstations, seating, tables, storage and shelving, filing, trash receptacles, clocks, framed artwork, artificial plants, and other accessories. Contract documentation is required to facilitate pricing, procurement and installation. The FF&E package is based on the furniture footprint developed in the Structural Interior Design (SID) portion of the interior design. Develop the FF&E package concurrently with the building design to ensure that there is coordination between the electrical outlets, switches, J-boxes, communication outlets and connections, and lighting as appropriate. In addition, coordinate layout with other building features such as architectural elements, thermostats, location of TV's, GF/GI equipment (for example computers, printers, copiers, shredders, faxes), etc. Locate furniture in front of windows only if the top of the item falls below the window and unless otherwise noted, do not attach furniture including furniture systems to the building. If project has SIPRNET and/or NIPRNET, coordinate furniture layout with SIPRNET and NIPRNET separation requirements. Verify that access required by DOIM for SIPRNET box and conduit is provided. The DOR shall interview appropriate Government personnel to determine FF&E requirements for furniture and furnishings prior to preparation of the scheme to be presented. Determine FFE items and quantities by, but not limited to: (1) the number of personnel to occupy the building, (2) job functions and related furniture/office equipment to support the job function, (3) room functions, (4) rank and grade. Present original sets of the scheme to reviewers at an interim design conference upon completion of the interim architectural submittal or three months prior to the submittal of the final FF&E package (whichever comes first).

Design may proceed to final with the FF&E scheme presented at the conclusion of the interim phase, after resolutions to the comments have been agreed upon between DOR and Government reviewers.

Provide six copies of the electronic versions of all documents upon completion of the final architectural submittal or ten months prior to the contract completion date (whichever comes first), to ensure adequate time for furniture acquisition. Provide unbound, electronic drawings in CAD and BIM. Provide all files needed to view complete drawings. Submit all text documents in Microsoft Word or Excel..

Submit three copies of the final and complete FF&E information and samples in 8 ½" x 11" format using three ring binders with pockets on the inside of the cover upon completion of the final architectural submittal or ten months prior to the contract completion date (whichever comes first). Use more than one binder when there are numerous pages with thick samples. Large D-ring binders are preferred to O-ring binders. Use page protectors that are strong enough to keep pages from tearing out for upholstery and finish boards. Anchor large or heavy samples with mechanical fasteners, Velcro, or double-faced foam tape rather than rubber cement or glue. Fold out items must have a maximum spread of 25 ½". Provide cover and spine inserts sheets identifying the document as "Furniture, Fixtures & Equipment" package and include the project title and location, project number, Contractor/A/E name and phone number(s), submittal stage and date.

Provide electronic copies of all documents upon completion of the final architectural submittal or ten months prior to the contract completion date (whichever comes first), to ensure adequate time for furniture acquisition. Provide six compact disks with all drawings files needed to view the complete drawings unbound and in the latest version AutoCAD. Provide six additional compact disks of all text documents in Microsoft Word or Excel.

Design submittal requirements include, but are not limited to:

1.1.1. Narrative of Interior Design Objectives

Provide a narrative description of the furniture, to include functional, safety and ergonomic considerations, durability, sustainability, aesthetics, and compatibility with the building design.

1.1.2. Furniture Order Form

Prepare one Furnishings Order Form for each item specified in the design. This form identifies all information required to order each individual item. In addition to the project name and location, project number, and submittal phase, the order form must include:

- (a) Furniture item illustration and code
- (b) Furniture item name
- (c) Job name, location, and date
- (d) General Services Administration (GSA) FSC Group, part, and section
- (e) Manufacturer, Product name and Product model number or National Stock Number (NSN)
- (f) Finish name and number (code to finish samples)
- (g) Fabric name and number, minimum Wyzenbeek Abrasion Test double rubs (code to fabric samples)
- (h) Dimensions
- (i) Item location by room number and room name
- (j) Quantity per room
- (k) Total quantity
- (l) Special instructions for procurement ordering and/or installation (if applicable)
- (m) Written Product Description: include a non-proprietary paragraph listing the salient features of the item to include but not limited to:
 - (1) required features and characteristics
 - (2) ergonomic requirements
 - (3) functional requirements
 - (4) testing requirements
 - (5) furniture style
 - (6) construction materials
 - (7) minimum warranty

The following is an example for “m” features and characteristics, ergonomic requirements and functional requirements:

Chair Description:

- (1) Mid-Back Ergonomic Task Chair
- (2) Pneumatic Gaslift; Five Star Base
- (3) Mesh Back; Upholstered Seat
- (4) Height and Width Adjustable Task Arms:
 - a. Arm Height: 6”- 11” (+-1/2”)
 - b. Arm Width: 2”– 4” adjustment
- (5) Height Adjustable Lumbar Support
- (6) Adjustable Seat Height 16”-21” (+- 1”)
- (7) Sliding Seat Depth Adjustment 15”-18” (+-1”)
- (8) Standard Hard Casters (for carpeted areas)
- (9) Overall Measurements:
 - a. Overall width: 25” - 27”
 - b. Overall depth: 25”– 28”

(10) Must have a minimum of the following adjustments (In addition to the above):

- a. 360 Degree Swivel
- b. Knee-Tilt with Tilt Tension
- c. Back angle
- d. Forward Tilt
- e. Forward Tilt and Upright Tilt Lock

For projects with systems furniture, also provide a written description of the following minimum requirements:

- (1) Type furniture systems (panel, stacking panels, spine wall, desk based system, or a combination)
- (2) Minimum noise reduction coefficient (NRC)
- (3) Minimum sound transfer coefficient (STC)
- (4) Minimum flame spread and smoke development
- (5) UL testing for task lighting and electrical system
- (6) Panel widths and heights and their locations (this may be done on the drawings) Worksurface types and sizes (this may be done on the drawings)
- (7) Worksurface edge type
- (8) Varying panel/cover finish materials and locations (locations may be shown on the drawings)
- (9) Storage requirements
- (10) Keyboard requirements
- (11) Lock and keying requirements
- (12) Accessory components (examples: tack boards, marker boards, paper management)
- (13) Electrical and communication raceway requirement; type, capacity and location (base, beltline, below and/or above beltline)
- (14) Locations of communication cables (base, beltline, below and/or above beltline, top channel)
- (15) Types of electrical outlets
- (16) Types of communication jacks; provided and installed by others
- (17) Locations of electrical outlets and communication jacks (this may be done on the drawings)
- (18) Type of cable (examples: Cat. 5, Cat. 6, fiber optic; UTP or STP, etc.) system needs to support; provided and installed by others

1.1.3. Alternate Manufacturer List

Provide a table consisting of major furniture items that lists the manufacturers products specified on the Order Form and two alternate manufacturers. Major furniture items include, but are not limited to, casegoods, furniture systems, seating, and tables. Organize matrix by item code and item name. Supply alternates that are available on GSA Schedule and meet the requirements of the Furniture Order Form. One of the two alternates must be from UNICOR if possible. Provide manufacturer name address, telephone number, product series and product name for each alternate manufacturer.

1.1.4. FF&E Procurement List

Provide a table that lists all FF&E furniture, mission unique equipment and building Contractor Furnished/Contractor Installed (CF/CI) items. Give each item a code and name and designate whether item will be procured as part of the FF&E furniture, mission unique equipment or the building construction contract. Use the item code to key all FF&E documents including location plans, color boards, data sheets, cost estimate, etc.

1.1.5. Points of Contact (POCs)

Provide a comprehensive list of POCs needed to implement the FF&E package. This would include but not be limited to appropriate project team members, using activity contacts, interior design representatives, construction contractors and installers involved in the project. In addition to name, address, phone, fax and email, include each contact's job function. Divide the FF&E package into different sections based on this listing, applies to order forms and cost estimates.

1.1.6. Color Boards

Provide color boards for all finishes and fabrics for all FF&E items. Finishes to be included but not limited to paint, laminate, wood finish, fabric, etc.

1.1.7. Itemized Furniture Cost Estimate

Provide an itemized cost estimate of furnishings keyed to the plans and specifications of products included in the package. This cost estimate should be based on GSA price schedules. The cost estimate must include separate line items for general contingency, installation, electrical hook-up for systems furniture or other furniture requiring hardwiring by a licensed electrician, freight charges and any other related costs. Installation and freight quotes from vendors should be use in lieu of a percentage allowance when available. Include a written statement that the pricing is based on GSA schedules. An estimate developed by a furniture dealership may be provided as support information for the estimate, but must be separate from the contractor provided estimate.

1.2. INTERIOR DESIGN DOCUMENTS

1.2.1. Overall Furniture and Area Plans

Provide floor Plans showing locations and quantities of all freestanding, and workstation furniture proposed for each floor of the building. Key each room to a large scale Furniture Placement Plan showing the furniture configuration, of all furniture. Provide enlarged area plans with a key plan identifying the area in which the building is located. Key all the items on the drawings by furniture item code. Do not provide manufacturer specific information such as product names and numbers on drawings, Drawings shall be non-proprietary. This is typical for FFE on all plans, including those mentioned below.

1.2.2. Workstation Plans

Show each typical workstation configuration in plan view, elevations or isometric view. Drawings shall illustrate panels and all major components for each typical workstation configuration. Identify workstations using the same numbering system as shown on the project drawings. Key components to a legend on each sheet which identifies and describes the components along with dimensions. Provide the plan, elevations and isometric of each typical workstation together on the same drawing sheet.

1.2.3. Panel Plans

Show panel locations and critical dimensions from finished face of walls, columns, panels including clearances and aisle widths. Key panel assemblies to a legend which shall include width, height, configuration of frames, panel fabric and finishes (if there are different selections existing within a project), powered or non-powered panel and wall mount locations.

1.2.4. Desk Plans

Provide typical free standing desk configurations in plan view, elevation or isometric view and identify components to clearly represent each desk configuration.

1.2.5. Reflected Ceiling Plans

Provide typical plans showing ceiling finishes and heights, lighting fixtures, heating ventilation and air conditioning supply and return, and sprinkler head placement for coordination of furniture.

1.2.6. Electrical and Telecommunication Plans

Show power provisions including type and locations of feeder components, activated outlets and other electrical components. Show locations and quantities of outlets for workstations. Clearly identify different outlets, i.e. electrical, LAN and telecommunication receptacles indicating each type proposed. Show wiring configuration, (circuiting, switching, internal and external connections) and provide as applicable.

1.2.7. Artwork Placement Plans

Provide an Artwork Placement Plan to show location of artwork, assign an artwork item code to each piece of artwork. As an alternative, artwork can be located on the Furniture Plans. Provide a schedule that identifies each piece by room name and number. Provide installation instructions; include mounting height.

1.2.8. Window Drapery Plans

Provide Interior Window Drapery Plans. Key each drapery treatment to a schedule showing color, pattern, material, drapery size and type, draw direction, location and quantities.

1.3. FURNITURE SELECTION

1.3.1. Select furniture from the GSA Schedules. Specify furniture available open market when an item is not available on the GSA Schedules. Provide justification for items not available on the GSA Schedules.

1.3.2. To the greatest extent possible when specifying furniture work within a manufacturer's family of furniture for selections, example: Steelcase, Turnstone, Brayton International, Metro, and Vecta are all Steelcase companies. Each alternate should also be specified from a manufacturer's family of furniture, example: first set of alternates would be specified from Knoll's family of furniture and the second from Herman Miller family of furniture. It may be necessary to make some selections from other than a manufacturer's family of furniture if costs are not reasonable for particular items, some items are not available or appropriate for the facility or the items are not on GSA Schedule. If this occurs, consider specifying product from an open line that is accessible by numerous dealerships. Select office furniture including case goods, tables, storage, seating, etc. that is compatible in style, finish and color. Select furniture that complies with ANSI/BIFMA and from manufacturer's standard product line as shown in the most recent published price list and/or amendment and not custom product.

1.4. CONSTRUCTION

1.4.1. Provide knee space at workstations and tables that is not obstructed by panels/legs that interfere with knee space of seated person and provide desks, storage and tables with leveling devices to compensate for uneven floors.

1.4.2. Provide worksurface tops constructed to prevent warpage. Provide user friendly features such as radius edges. Do not use sharp edges and exposed connections and ensure the underside of desks, tables and worksurfaces are completely and smoothly finished. Provide abutting worksurfaces that mate closely and are of equal heights when used in side-by-side configurations in order to provide a continuous and level worksurface.

1.4.3. Drawers shall stay securely closed when in the closed position and protect wires from damage during drawer operation. Include a safety catch to prevent accidental removal when fully open.

1.4.4. Unless otherwise noted, specify lockable desks and workstations and storage of steel construction. Use tempered glass glazing when glazing is required.

1.5. FINISHES AND UPHOLSTERY

1.5.1. Specify neutral colors for casegoods, furniture systems, storage and tables. Specify desk worksurfaces and table tops that are not too light or too dark in color and have a pattern to help hide soiling. Accent colors are allowed in break and lounge areas. Keep placement of furniture systems panel fabric accent colors to a minimum. All finishes shall be cleanable with ordinary household cleaning solutions.

1.5.2. Use manufacturer's standard fabrics; including textile manufacturers fabrics that have been graded into the furniture manufacturers fabric grades and are available through their GSA Schedule. Customers Own Material

(COM) can be used in headquarter buildings in command suites with executive furniture. Coordinate specific locations with Corps of Engineers Interior Designer.

1.5.3. Specify seating upholstery that meets Wyzenbeek Abrasion Test, 55,000 minimum rubs. Specify a soil retardant finish for woven fabrics if Crypton or vinyl upholstery is not provided for seating in dining areas. Use manufacturer's standard fabrics. This includes textile manufacturers fabrics that have been graded into the furniture manufactures fabric grades and are available through their GSA Schedule. Specify upholstery and finish colors and patterns that help hide soiling. Specify finishes that can be cleaned with ordinary household cleaning solutions.

1.6. ACCESSORIES

1.6.1. Specify all accessories required for completely finished furniture installation. Provide filing cabinets and storage for office supplies. Provide tack surfaces at workstations with overhead storage. Provide tackable surfaces at workstations with overhead storage.

1.6.2. Not Used.

1.6.3. Workstations are to be equipped with stable keyboard trays that have height adjustability, tilting capability, including negative tilt, have a mouse pad at same height as the keyboard tray that can accommodate both left and right handed users, and retractable under worksurface.

1.7. MISSION UNIQUE EQUIPMENT

Funding for FF&E furniture items and mission unique equipment (MUE) items are from two different sources. Separate the designs and procurement documentation for FFE items and MUE. MUE includes, but is not limited to, items such as industrial shelving, workbenches, appliances, fitness equipment, IT equipment and supporting carts. The User will purchase and install mission unique equipment items, unless otherwise noted. Identify locations of known MUE items such as industrial shelving, workbenches, appliances, etc. for space planning purposes.

1.8. SUSTAINABILITY

1.8.1. For all designs provided regardless of facility type, make every effort to implement all aspects of sustainability to the greatest extent possible for all the selections made in the FF&E package. This includes but is not limited to the selection of products that consider: **Material Chemistry and Safety of Inputs** (What chemicals are used in the construction of the selections?); **Recyclability** (Do the selections contain recycled content?); **Disassembly** (Can the selections be disassembled at the end of their useful life to recycle their materials?).

1.8.2. Make selections to the greatest extent possible of products that possess current McDonough Braungart Design Chemistry ([MBDC](#)) certification or other "third-party" certified Cradle to Cradle program, Forest Stewardship Council (FSC) certification, GREENGAURD certification or similar "third-party" certified products consisting of low-emitting materials.

1.9. FURNITURE SYSTEMS

1.9.1. General.

Where appropriate, design furniture systems in open office areas. Coordinate style and color of furniture systems with other storage, seating, etc. in open office areas. Minimize the number of workstation typicals and the parts and pieces required for the design to assist in future reconfiguration and inventorying.

1.9.2. Connector Systems.

Specify a connector system that allows removal of a single panel or spine wall within a typical workstation configuration without requiring disassembly of the workstation or removal of adjacent panels. Specify connector system with tight connections and continuous visual seals. When Acoustical panels are used, provide connector system with continuous acoustical seals. Specify concealed clips, screws, and other construction elements, where possible.

1.9.3. Panels and Spine Walls

Specify panels and spine walls with hinged or removable covers that permit easy access to the raceway when required but are securely mounted and cannot be accidentally dislodged under normal conditions. Panels shall be capable of structurally supporting more than 1 fully loaded component per panel per side. Raceways are to be an integral part of the panel and must be able to support lay-in cabling and have a large capacity for electrical and IT. Do not thread cables through the frame.

1.9.4. Electrical And Information/Technology (IT)

Design furniture with electrical systems that meets requirements of UL 1286 when powered panels are required and UL approved task lights that meet requirements of NFPA 70. Dependent on user requirements and Section 01 10 00, paragraph 3 requirements, it is recommended that workstation electrical and IT wiring entry come from the building walls to eliminate the use of power poles and access at the floor. Design electrical and IT systems that are easily accessed in the spine wall and panels without having to move return panels and components. Electrical and IT management will be easily accessible by removable wall covers which can be removed while workstation components are still attached. Specify connector system that has continuation of electrical and IT wiring within workstations and workstation to workstation.

1.9.5. Pedestals

Specify pedestals that are interchangeable from left to right, and right to left, and retain pedestal locking system capability.

1.10. EXECUTIVE FURNITURE

1.10.1. Design for executive furniture in command areas, coordinate specific locations with Corps of Engineers Interior Designer. Use upgraded furniture, upholsteries and finishes in command suites. This includes but is not limited to wood casegoods, seating and tables. Select executive furniture casegoods from a single manufacturer and style line, to include workstations, credenzas, filing, and storage, etc.

1.10.2. Specify furniture with wood veneer finish (except worksurfaces) with mitered solid wood edge of same wood type. Provide worksurface plastic laminate that closely matches adjacent wood veneer. Other executive office furniture such as seating, tables, executive conference room furniture, etc. shall be compatible in style, finish and color with executive furniture casegoods.

1.11. SEATING

1.11.1. General

Specify appropriate chair casters and glides for the floor finish where the seating is located. Universal casters that are appropriate for both hard surface flooring and carpet are preferred. All seating shall support up to a minimum of 250 lbs.

1.11.2. Desk and Guest Seating

Select ergonomic desk chairs with casters, non-upholstered adjustable arms, waterfall front, swivel, tilt, variable back lock, adjustable back height or adjustable lumbar support, pneumatic seat height adjustment, and padded, contoured upholstered seat and back. Desk and guest chair backs may be other than upholstered such as mesh fabric if it is ergonomically designed, forms to back and is comfortable. Depending on scale of desk chair provide seat pan forward and back adjustment to increase or decrease depth of seat pan. All desk chairs shall have an adjustable seat height range of 4 1/2", range to include 16 1/2"-20". Select guest chairs that are compatible in style, finish and color with the desk chairs.

1.11.3. Conference Room Seating

At tables, select ergonomic conference seating with casters, non-upholstered arms, waterfall front, swivel, tilt, pneumatic seat height adjustment, and padded, contoured seat and back, unless otherwise noted. Select arm height and/or design that allows seating to be moved up closely to the table top. Conference chair backs may be other than upholstered such as mesh fabric if it is ergonomically designed, forms to back and is comfortable. Perimeter conference chairs shall be compatible in style, finish and color with conference seating at the tables.

1.11.4. Lounge, Waiting and Reception Area Seating

Select seating with arms and cushioned, upholstered seat and back. In heavy use areas, arms shall be easily cleaned such as non-upholstered arms or upholstered arms with wood arm caps unless otherwise noted.

1.11.5. Break Room Seating

Select stackable seating that is easily cleaned. Seating shall be appropriate for table and counter heights as applicable with non-upholstered arms if arms are required. Chairs shall have metal legs and composite materials for seats.

1.11.6. Lounge, Waiting and Reception Furniture.

Design for end and coffee tables with plastic laminate tops that are compatible in style finish and color with the seating.

1.12. FILING AND STORAGE.

Select storage and shelving units that meet customer's functional load requirements for stored items. Specify counterweights for filing cabinets when required by the manufacturer for stability. File drawers shall allow only one drawer to be opened at a time. Provide heavy duty storage and shelving if information is not available.

1.13. TRAINING TABLES.

Don't use plastic laminate self edge. Training tables shall be reconfigurable, moveable and storable; lighter weight folding with dollies or casters as necessary. Specify dollies if required.

1.14. FURNITURE WARRANTIES.

Specify manufacturer's performance guarantees or warranties that include parts, labor and transportation as follows:

Furniture System, unless otherwise noted – 10 year minimum
Furniture System Task Lights – 2 year minimum, excluding bulbs
Furniture System Fabric – 3 year minimum
Desks - 10 year minimum
Seating, unless otherwise noted - 10 year minimum
Seating Mechanisms and Pneumatic Cylinders - 10 years
Fabric - 3 years minimum
Filing and Storage - 10 year minimum
Tables, unless otherwise noted - 10 year minimum
Table Mechanisms – 5 year
Table Ganging Device - 1 year
Items not listed above - 1 year minimum

ATTACHMENT C TRACKING COMMENTS IN DRCHECKS

1.0 General

The Government and DB Contractor shall set up the project in Dr Checks. Throughout the design process, the parties shall enter, track, and back-check comments using the DrChecks system. Government reviewers enter design review comments into DrChecks. Designers of Record shall annotate comments timely and specifically to indicate exactly what action will be taken or why the action is not required. Comments considered critical by the conference participants shall be flagged as such.

2.0 DrChecks Review Comments

The Contractor and the Government shall monitor DrChecks to assure all comments are annotated and agreed to by the designers and reviewers prior to the next submittal. The DrChecks comments and responses shall be printed and included in the design analysis for record.

2.1. Conference participants (reviewers) will expect coordination between Design Analysis calculations and the submitted design. Reviewers will also focus on the design submittal's satisfaction of the contract requirements.

2.2. The Designers of Record shall answer each comment in DrChecks with a formal response prior to the next submittal, clearly indicating what action will be taken and what drawing/spec will change. Designers of Record are encouraged to directly contact reviewers to discuss and agree to the formal comment responses rather than relying only on DrChecks and review meetings to discuss comments. With the next design conference, reviewers will back-check answers to the comments against the submittal, in addition to reviewing additional design work.

2.3. Comments that, in the DB Contractor's opinion, require effort outside the scope of the contract shall be clearly indicated as such in DrChecks. The DB Contractor shall not proceed with work outside the contract until a modification to the contract is properly executed, if one is necessary.

3.0 DrChecks Initial Account Set-Up

To initialize an office's use of DrChecks, choose a contact person within the office to call the DrChecks Help Desk at 800-428-HELP, M-F, 8AM-5PM, Central time. This POC will be given an office password to distribute to others in the office. Individuals can then go to the hyperlink at <http://www.projnet.org> and register as a first time user. Upon registration, each user will be given a personal password to the DrChecks system.

3.1. Once the office and individuals are registered, the COE's project manager or lead reviewer will assign the individuals and/or offices to the specific project for review. At this point, persons assigned can make comments, annotate comments, and close comments, depending on their particular assignment.

4.0 DrChecks Reviewer Role

The Contractor is the technical reviewer and the Government is the compliance reviewer of the DB designers design documents. Each reviewer enters their own comments into the Dr Checks system. To enter comments:

4.1. Log into DrChecks.

4.2. Click on the appropriate project.

4.3. Click on the appropriate review conference. An Add comment screen will appear.

4.4. Select or fill out the appropriate sections (particularly comment discipline and type of document for sorting) of the comment form and enter the comment in the space provided.

4.5. Click the Add Comment button. The comment will be added to the database and a fresh screen will appear for the next comment you have.

4.6. Once comments are all entered, exit DrChecks by choosing "My Account" and then Logout.

5.0 DrChecks Comment Evaluation

The role of the designers of record is to evaluate and respond to the comments entered by the Government reviewers and by the DB Contractor. To respond to comments:

5.1. Log into DrChecks.

5.2. Click on the appropriate project.

5.3. Under "Evaluate" click on the number under "Pending".

5.4. Locate the comments that require your evaluation. (Note: If you know the comment number you can use the Quick Pick window on your home page in DrChecks; enter the number and click on go.)

5.5. Select the appropriate evaluation (concur, non-concur, for information only, or check and resolve) and add the response.

5.6. Click on the Add button. The evaluation will be added to the database and a fresh screen will appear with the next comment.

5.7. Once evaluations are all entered, exit DrChecks by choosing "My Account" and then Logout.

6.0 DrChecks Back-check

At the following design conference, participants will back-check comment annotations against newly presented documents to verify that the designers' responses are acceptable and completed. The Contractor and Government reviewers shall either enter additional back-check comments, as necessary or close those that are resolved as a result of the design conferences:

6.1. Log into DrChecks.

6.2. Click on the appropriate project.

6.3. Under "My Backcheck" click on the number under "Pending".

6.4. If you agree with the designer's response select "Close Comment" and add a closing response if desired.

6.5. If you do not agree with the designer's response or the submittal does not reflect the response given, select "Issue Open", enter additional information.

6.6. Click on the Add button. The back-check will be added to the database and a fresh screen will appear with the next comment.

6.7. Once back-checks are all entered, exit DrChecks by choosing "My Account" and then Logout. The design is completed and final when there are no pending comments to be evaluated and there are no pending or open comments under back-check.

ATTACHMENT D
SAMPLE FIRE PROTECTION AND LIFE SAFETY CODE REVIEW

Instructions: Use the information outlined in this document to provide the minimum requirement for development of Fire Protection and Life Safety Code submittals for all building projects. Additional and supplemental information may be used to further develop the code review. Insert N/A after criteria, which may be "not applicable".

1.0 SAMPLE FIRE PROTECTION AND LIFE SAFETY CODE REVIEW

- 1.1. Project Name (insert name and location)
- 1.2. Applicable Codes and Standards
 - 1.2.1. Unified Facilities Criteria (UFC): 3-600-01, Design: Fire Protection Engineering For Facilities
 - 1.2.2. International Building Code (IBC) for fire resistance requirements, allowable floor area, building height limitations and building separation distance requirements, except as modified by UFC 3-600-01.
 - 1.2.3. National Fire Protection Association (NFPA) 101 Life Safety Code (latest edition), for building egress and life safety and applicable criteria in UFC 3-600-01.
 - 1.2.4. ADA and ABA Accessibility Guidelines. For Buildings and Facilities See Section 01 10 00, Paragraph 3 for facility specific criteria.
- 1.3. Occupancy Classification
IBC chapters 3 and 4
- 1.4. Construction Type
IBC chapter 6
- 1.5. Area Limitations
IBC chapter 5, table 503
- 1.6. Allowable Floor Areas
IBC section 503, 505
- 1.7. Allowable area increases
IBC section 506, 507
- 1.8. Maximum Height of Buildings
IBC section 504
- 1.9. Fire-resistive substitution
- 1.10. Occupancy Separations
IBC table 302.3.2
- 1.11. Fire Resistive Requirements
 - 1.11.1. Exterior Walls - [] hour rating, IBC table 601, 602
 - 1.11.2. Interior Bearing walls - [] hour rating
 - 1.11.3. Structural frame - [] hour rating
 - 1.11.4. Permanent partitions - [] hour rating

- 1.11.5. Shaft enclosures - [] hour rating
- 1.11.6. Floors & Floor-Ceilings - [] hour rating
- 1.11.7. Roofs and Roof Ceilings - [] hour rating
- 1.12. Automatic Sprinklers and others used to determine the need for automatic Extinguishing Equipment, Extinguishing Systems, Foam Systems, Standpipe
 - 1.12.1. UFC 3-600-01, chapters 4 and 6 systems, wet chemical systems, etc. State which systems are required and to what criteria they will be designed.
 - 1.12.2. UFC 3-600-01, Appendix B Occupancy Classification. Note the classification for each room. This may be accomplished by classifying the entire building and noting exceptions for rooms that differ (E.g. The entire building is Light Hazard except boiler room and storage rooms which are [], etc.)
 - 1.12.3. UFC 3-600-01, Chapter 3 Sprinkler Design Density, Sprinkler Design Area, Water Demand for Hose Streams (supply pressure and source requirements).
 - 1.12.4. UFC 3-600-01, Chapter 4 Coverage per sprinkler head. Extended coverage sprinkler heads are not permitted.
 - 1.12.5. Available Water Supply. Provide the results of the water flow tests showing the available water supply static pressure and residual pressure at flow. Based on this data and the estimated flow and pressure required for the sprinkler system, determine the need for a fire pump.
 - 1.12.6. NFPA 13, Para. 8.16.4.6.1. Provide backflow preventer valves as required by the local municipality, authority, or water purveyor. Provide a test valve located downstream of the backflow preventer for flow testing the backflow preventer at full system demand flow. Route the discharge to an appropriate location outside the building.
- 1.13. Kitchen Cooking Exhaust Equipment
Describe when kitchen cooking exhaust equipment is provided for the project. Type of extinguishing systems for the equipment should be provided. per NFPA 96. Show all interlocks with manual release switches, fuel shutoff valves, electrical shunt trips, exhaust fans, and building alarms.
- 1.14. Portable Fire Extinguishers, fire classification and travel distance. per NFPA 10
- 1.15. Enclosure Protection and Penetration Requirements. - Opening Protectives and Through Penetrations
 - 1.15.1. IBC Section 712, 715 and Table 715.3. Mechanical rooms, exit stairways, storage rooms, janitor [] hour rating. IBC Table 302.1.1
 - 1.15.2. Fire Blocks, Draft Stops, Through Penetrations and Opening Protectives
- 1.16. Fire Dampers. Describe where fire dampers and smoke dampers are to be used (IBC Section 716 and NFPA 90A). State whether isolation smoke dampers are required at the air handler.
- 1.17. Detection Alarm and Communication. UFC 3-600-01, (Chapter 5); NFPA 101 para. 3.4 (chapters 12-42); NFPA 72
- 1.18. Mass Notification. Describe building/facility mass notification system (UFC 4-021-01) type and type of base-wide mass notification/communication system. State whether the visible notification appliances will be combined with the fire alarm system or kept separate. (Note: Navy has taken position to combine visible notification appliances with fire alarm).
- 1.19. Interior Finishes (classification). NFPA 101.10.2.3 and NFPA 101.7.1.4
- 1.20. Means of Egress

- 1.20.1. Separation of Means of Egress, NFPA 101 chapters 7 and 12-42; NFPA101.7.1.3
- 1.20.2. Occupant Load, NFPA101.7.3.1 and chapters 12-42.
- 1.20.3. Egress Capacity (stairs, corridors, ramps and doors) NFPA101.7.3.3
- 1.20.4. Number of Means of Egress, NFPA101.7.4 and chapters 12-42.
- 1.20.5. Dead end limits and Common Path of Travel, NFPA 101.7.5.1.6 and chapters 12-42.
- 1.20.6. Accessible Means of Egress (for accessible buildings), NFPA101.7.5.4
- 1.20.7. Measurement of Travel Distance to Exits, NFPA101.7.6 and chapters 12-42.
- 1.20.8. Discharge from Exits, NFPA101.7.7.2
- 1.20.9. Illumination of Means of Egress, NFPA101.7.8
- 1.20.10. Emergency Lighting, NFPA101.7.9
- 1.20.11. Marking of Means of Egress, NFPA101.7.10
- 1.21. Elevators, UFC 3-600-01, Chapter 6; IBC and ASME A17.1 - 2000,(Safety Code for Elevators and Escalators)
- 1.22. Accessibility Requirements, ADA and ABA Accessibility Guidelines for Buildings and Facilities
- 1.23. Certification of Fire Protection and Life Safety Code Requirements. (Note: Edit the Fire team membership if necessary). Preparers of this document certify the accuracy and completeness of the Fire Protection and Life Safety features for this project in accordance with the attached completed form(s).
- 1.24. Designer of Record. Certification of Fire protection and Life Safety Code Requirements. (Note: Edit the Fire team members if necessary). Preparers of this document certify the accuracy and completeness of the Fire Protection and Life Safety features of this project.

Fire Protection Engineer of Record:

Signature and Stamp

Date

OR

Architect of Record:

Signature and Stamp

Date

Mechanical Engineer of Record:

Signature and Stamp

Date

Electrical Engineer of Record:

Friday, July 23, 2010

Signature/Date

ATTACHMENT E
LEED SUBMITTALS

LEED Credit Paragraph		Contractor Check Here if Credit is Claimed	LEED-NC v3 Submittals (OCT09)		Provide for Credit Audit Only		Date Submitted (to be filled in by Contractor)	Government Reviewer's Use
PAR		FEATURE	DUE AT	REQUIRED DOCUMENTATION		DATE	REV	
GENERAL								
		GENERAL - All calculations shall be in accordance with LEED 2009 Reference Guide.						
		GENERAL: Obtain excel version of this spreadsheet at http://en.sas.usace.army.mil/enWeb/EngineeringCriteria .						
		GENERAL - For all credits, narrative/comments may be added to describe special circumstances or considerations regarding the project's credit approach.						
		GENERAL - Include all required LEED drawings indicated below in contract drawings with applicable discipline drawings, labeled For Reference Only.						
		NOTE: Each submittal indicated with "****" differs from LEED certified project submittals by either having a different due date or being an added submittal not required by GBCI.						
		NOTE: Projects seeking LEED certification need only submit to GBCI whatever documentation is acceptable to GBCI (for example, licensed professional certifications). This checklist identifies what must be submitted to the Government for internal review purposes. Government review of LEED documentation in no way supercedes or modifies the requirements and rulings of GBCI for purposes of compliance with project requirement to obtain LEED certification.						
		GENERAL - Audit documentation may include but is not limited to what is indicated in this table.						
			Closeout	List of all Final Design submittals revised after final design to reflect actual closeout conditions. Revised Final Design submittals. - OR - Statement confirming that no changes have been made since final design that effect final design submittal documents.				Proj Engr (PE)
CATEGORY 1 - SUSTAINABLE SITES								
SSPR1		Construction Activity Pollution Prevention (PREREQUISITE)	**Final Design		List of drawings and specifications that address the erosion control, particulate/dust control and sedimentation control measures to be implemented.			CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.			CIV
			**Final Design		Narrative that indicates which compliance path was used (NPDES or Local standards) and describes the measures to be implemented on the project. If a local standard was followed, provide specific information to demonstrate that the local standard is equal to or more stringent than the NPDES program.			CIV
SS1		Site Selection	Final Design		Statement confirming that project does not meet any of the prohibited criteria.			CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.			CIV
			Final Design	X	LEED Site plan drawing that shows all proposed development, line depicting boundary of all bodies of water and/or wetlands within 100 feet of project boundary and a line depicting 5' elevation above 100 year flood line that falls within project boundary. Not required if neither condition applies.			CIV
SS2		Development Density & Community Connectivity	Final Design		Option 1: LEED Site vicinity plan showing project site and surrounding development. Show density boundary or note drawing scale.			CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.			CIV
			Final Design		Option 1: Table indicating, for project site and all surrounding sites within density radius (keyed to site vicinity plan), site area and building area. Project development density calculation. Density radius calculation. Development density calculation within density radius.			CIV
			Final Design		Option 2: LEED Site vicinity plan showing project site, the 1/2 mile community radius, pedestrian walkways and the locations of the residential development(s) and Basic Services surrounding the project site.			CIV
			Final Design		Option 2: List (including business name and type) of all Basic Services facilities within the 1/2 mile radius, keyed to site vicinity plan.			CIV
SS3		Brownfield Redevelopment	Final Design		Narrative describing contamination and the remediation activities included in project. Include statement indicating how site was determined to be a brownfield.			CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.			CIV
SS4.1		Alternative Transportation: Public Transportation Access	Final Design		Statement indicating which option for compliance applies. State whether public transportation is existing or proposed and, if proposed, cite source of this information.			CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.			CIV
			Final Design		Option 1: LEED Site vicinity plan showing project site, mass transit stops and pedestrian path to them with path distance noted.			CIV
			Final Design		Option 2: LEED Site vicinity plan showing project site, bus stops and pedestrian path to them with path distance noted.			CIV
SS4.2		Alternative Transportation: Bicycle Storage & Changing Rooms	Final Design		FTE calculation. Bicycle storage spaces calculation. Shower/changing facilities calculation.			CIV
			Final Design		List of drawings that show the location(s) of bicycle storage areas. Statement indicating distance from building entrance.			CIV
			Final Design		List of drawings that show the location(s) of shower/changing facilities and, if located outside the building, statement indicating distance from building entrance.			CIV

Friday, July 28, 2023

Friday, July 23, 2010

LEED Credit Paragraph	Contractor Check Here if Credit is Claimed	LEED-NC v3 Submittals (OCT09)	Provide for Credit Audit Only		Date Submitted (to be filled in by Contractor)	Government Reviewer's Use
PAR		FEATURE	DUE AT	REQUIRED DOCUMENTATION	DATE	REV
SS4.3		Alternative Transportation: Low Emitting & Fuel Efficient Vehicles	Final Design	Statement indicating which option for compliance applies. FTE calculation. Statement indicating total parking capacity of site.		CIV
			**Final Design	Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			Final Design	Option 1: Low-emission & fuel-efficient vehicle calculation.		CIV
			Final Design	Option 1: List of drawings and specification references that show location and number of preferred parking spaces for low-emission & fuel-efficient vehicles and signage.		CIV
			Final Design	Option 1: Statement indicating quantity, make, model and manufacturer of low-emission & fuel-efficient vehicles to be provided. Statement confirming vehicles are zero-emission or indicating ACEEE vehicle scores.		CIV
			Final Design	Option 2: Low-emission & fuel-efficient vehicle parking calculation.		CIV
			Final Design	Option 2: List of drawings and specification references that show location and number of preferred parking spaces and signage.		CIV
			Final Design	Option 3: Low-emission & fuel-efficient vehicle refueling station calculation.		CIV
			Final Design	Option 3: List of drawings and specifications indicating location and number of refueling stations, fuel type and fueling capacity for each station for an 8-hour period.		CIV
			Closeout	Option 3: Construction product submittals indicating what was provided and confirming compliance with respect to fuel type and fueling capacity for each station for an 8-hour period.		CIV
SS4.4		Alternative Transportation: Parking Capacity	Final Design	Statement indicating which option for compliance applies.		CIV
			**Final Design	Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			Final Design	Option 1: Preferred parking calculation including number of spaces required, total provided, preferred spaces provided and percentage.		CIV
			Final Design	Option 2: FTE calculation. Preferred parking calculation including number of spaces provided, preferred spaces provided and percentage.		CIV
			Final Design	Options 1 and 2: List of drawings and specification references that show location and number of preferred parking spaces and signage.		CIV
			Final Design	Option 3: Narrative indicating number of spaces required and provided and describing infrastructure and support programs with description of project features to support them.		CIV
SS5.1		Site Development: Protect or Restore Habitat	**Final Design	Option 1: List of drawing and specification references that convey site disturbance limits.		CIV
			**Final Design	Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			**Final Design	Option 2: LEED site plan drawing that delineates boundaries of each preserved and restored habitat area with area (sf) noted for each.		CIV
			**Final Design	Option 2: Percentage calculation of restored/preserved habitat to total site area. List of drawings and specification references that convey restoration planting requirements.		CIV
SS5.2		Site Development: Maximize Open Space	Final Design	Option 2: LEED site plan drawing delineating boundary of vegetated open space adjacent to building with areas of building footprint and designated open space noted.		CIV
			**Final Design	Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
SS6.1		Stormwater Design: Quantity Control	Final Design	Statement indicating which option for compliance applies.		CIV
			**Final Design	Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			Final Design	Option 1: Indicate pre-development and post-development runoff rate(cfs) and runoff quantity (cf) -OR - Narrative describing site conditions, measures and controls to be implemented to prevent excessive stream velocities and erosion.		CIV
			Final Design	Option 2: Indicate pre-development and post-development runoff rate(cfs) and runoff quantity (cf). Indicate percent reduction in each.		CIV
SS6.2		Stormwater Design: Quality Control	Final Design	For non-structural controls, list all BMPs used and, for each, describe the function of the BMP and indicate the percent annual rainfall treated. List all structural controls and, for each, describe the pollutant removal and indicate the percent annual rainfall treated.		CIV
			**Final Design	Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
SS7.1		Heat Island Effect: Non-Roof	**Final Design	LEED site plan drawing indicating locations and quantities of each paving type, including areas of shaded pavement. Percentage calculation indicating percentage of reflective/shaded/open grid area.		CIV
			**Final Design	Delineation and labeling of "LEED Project site boundary" on site plan.		CIV

Friday, July 23, 2010

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PAR		FEATURE	DUE AT	REQUIRED DOCUMENTATION	DATE	REV
SS7.2		Heat Island Effect: Roof	Final Design	Option 1: Percentage calculation indicating percentage of SRI compliant roof area. List of drawings and specification references that convey SRI requirements and roof slopes.		ARC
			Final Design	Option 1: List of specified roof materials indicating, for each, type, manufacturer, product name and identification if known, SRI value and roof slope.		ARC
			**Closeout	Option 1: List of installed roof materials indicating, for each, manufacturer, product name and identification, SRI value and roof slope.		PE
			Closeout	X Option 1: Manufacturer published product data or certification confirming SRI		PE
			Final Design	Option 2: Percentage calculation indicating percentage of vegetated roof area.		ARC
			Final Design	Option 3: Combined reflective and green roof calculation.		ARC
			Final Design	Option 3: List of specified roof materials indicating, for each, type, manufacturer, product name and identification if known, SRI value and roof slope.		ARC
			**Closeout	Option 3: List of installed roof materials indicating, for each, manufacturer, product name and identification, SRI value and roof slope.		PE
			Closeout	X Option 3: Manufacturer published product data or certification confirming SRI		PE
SS8		Light Pollution Reduction	Final Design	Interior Lighting: List of drawings and specification references that convey interior lighting requirements (location and type of all installed interior lighting, location of non-opaque exterior envelope surfaces, allowing confirmation that maximum candela value from interior fixtures does not intersect non-opaque building envelope surfaces). - OR - List of drawings and specification references that show automatic lighting controls compliance with credit requirement.		ELEC
			**Final Design	Delineation and labeling of "LEED Project site boundary" on site plan.		ELEC
			Final Design	Exterior Lighting: List of drawings and specification references that convey exterior lighting requirements (location and type of all site lighting and building façade/landscape lighting).		ELEC
			Final Design	Exterior Site Lighting Power Density (LPD): Tabulation for exterior site lighting indicating, for each location identification or description, units of measure, area or distance of the location, actual LPD using units consistent with ASHRAE 90.1, and the ASHRAE allowable LPD for that type of location. Percentage calculation of actual versus allowable LPD for all site lighting.		ELEC
			Final Design	Exterior Building Facade/Landscape Lighting Power Density (LPD): Tabulation for exterior building facade/landscape lighting indicating, for each location identification or description, units of measure, area or distance of the location, actual LPD using units consistent with ASHRAE 90.1, and the ASHRAE allowable LPD for that type of location. Percentage calculation of actual versus allowable LPD for all building facade/landscape lighting.		ELEC
			Final Design	Exterior Lighting IESNA Zone: Indicate which IESNA zone is applicable to the project.		ELEC
			Final Design	Exterior Lighting Site Lumen table indicating, for each fixture type, quantity installed, initial lamp lumens per luminaire, initial lamp lumens above 90 degrees from Nadir, total lamp lumens and total lamp lumens above 90 degrees. Percentage of site lamp lumens above 90 degrees from nadir to total lamp lumens.		ELEC
			Final Design	Exterior Lighting Narrative describing analysis used for addressing requirements for light trespass at site boundary and beyond.		ELEC
CATEGORY 2 – WATER EFFICIENCY						
WEPR1		Water Use Reduction: 20% Reduction	Final Design	Statement confirming which occupancy breakdown applies (default or special). For special occupancy breakdown, indicate source and explanation for ratio.		MEC
			Final Design	Occupancy calculation including male/female numbers for FTEs, visitors, students, customers, residential and other type occupants/users		MEC
			Final Design	Statement indicating percent of male restrooms with urinals. Statement indicating annual days of operation.		MEC

Friday, July 23, 2010

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PAR		FEATURE	DUE AT	REQUIRED DOCUMENTATION	DATE	REV
			Final Design	Baseline flush fixture calculation spreadsheet indicating, for each fixture type, gender, flush rate, daily uses per person for each occupant type identified in occupancy calculation and annual baseline flush fixture water usage.		MEC
			Final Design	Design case flush fixture calculation spreadsheet indicating, for each fixture type, gender, fixture manufacturer, fixture model number, flush rate, percent of occupants using this fixture type, daily uses per person for each occupant type identified in occupancy calculation and annual design case flush fixture water usage.		MEC
			Closeout	X Manufacturer published product data or certification confirming fixture water usage.		PE
WE1.1		Water Efficient Landscaping: Reduce by 50%	Final Design	Statement indicating which option for compliance applies.		CIV
			**Final Design	Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			Final Design	Calculation indicating, for baseline and design case, total water applied, total potable water applied, total non-potable water applied. Design case percent potable water reduction. If nonpotable water is used, indicate source of nonpotable water.		CIV
			Final Design	List of landscape plan drawings.		CIV
			Final Design	Narrative describing landscaping and irrigation design strategies, including water use calculation methodology used to determine savings and, if non-potable water is used, specific information about source and available quantity.		CIV
WE1.2		Water Efficient Landscaping: No Potable Water Use or No Irrigation	Same as WE1.1	Same as WE1.1		CIV
WE2		Innovative Wastewater Technologies	Final Design	Statement confirming which option for compliance applies.		MEC
			Final Design	Statement confirming which occupancy breakdown applies (default or special). For special occupancy breakdown, indicate source and explanation for ratio.		MEC
			Final Design	Occupancy calculation including male/female numbers for FTEs, visitors, students, customers, residential and other type occupants/users		MEC
			Final Design	Statement indicating percent of male restrooms with urinals. Statement indicating annual days of operation.		MEC
			Final Design	Baseline flush fixture calculation spreadsheet indicating, for each fixture type, gender, flush rate, daily uses per person for each occupant type identified in occupancy calculation and annual baseline flush fixture water usage.		MEC
			Final Design	Design case flush fixture calculation spreadsheet indicating, for each fixture type, gender, fixture manufacturer, fixture model number, flush rate, percent of occupants using this fixture type, daily uses per person for each occupant type identified in occupancy calculation and annual design case flush fixture water usage.		MEC
			Final Design	Option 1: If onsite non-potable water is used, identify source(s), indicate annual quantity from each source and indicate total annual quantity from all onsite non-potable water sources.		MEC
			Final Design	Option 1: Summary calculation indicating baseline annual water consumption, design case annual water consumption, non-potable annual water consumption and total percentage annual water savings.		MEC
			Final Design	Option 2: Statement confirming on-site treatment of all generated wastewater to tertiary standards and all treated wastewater is either infiltrated or used on-site.		MEC
			Final Design	Option 2: List of drawing and specification references that convey design of on-site wastewater treatment features.		CIV
			Final Design	Option 2: On-site water treatment quantity calculation indicating all on-site wastewater source(s), annual quantity treated, annual quantity infiltrated and annual quantity re-used on site from each source and totals for annual quantity treated, annual quantity infiltrated and annual quantity re-used on site from all sources.		CIV
			Final Design	Option 2: Wastewater summary calculation indicating design case annual flush fixture water usage, annual on-site water treatment and percentage sewage conveyance reduction.		MEC
			Final Design	Narrative describing project strategy for reduction of potable water use for sewage conveyance, including specific information on reclaimed water usage and treated wastewater usage.		MEC
WE3		Water Use Reduction: 30% - 40% Reduction	Same as WEPR1	Same as WEPR1		MEC

CATEGORY 3 – ENERGY AND ATMOSPHERE

Friday, July 23, 2010

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PAR		FEATURE	DUE AT	REQUIRED DOCUMENTATION	DATE	REV
EAPR1		Fundamental Commissioning of the Building Energy Systems (PREREQUISITE)	**Final Design	**Owner's Project Requirements document		ALL
			**Final Design	**Basis of Design document for commissioned systems		MEC, ELEC
			**Final Design	**Commissioning Plan		MEC, ELEC
			Closeout	Statement confirming all commissioning requirements have been incorporated into construction documents.		PE
			Closeout	Commissioning Report		PE
EAPR2		Minimum Energy Performance (PREREQUISITE)	Final Design	Statement listing the mandatory provisions of ASHRAE 90.1 that project meets relative to compliance with this prerequisite and indicating which compliance path was used.		MEC ELEC ARC
			Final Design	Statement indicating which compliance path option applies.		MEC
			Final Design	Option 1: Statement confirming simulation software capabilities and confirming assumptions and methodology.		MEC
			Final Design	Option 1: General information including simulation program, principal heating source, percent new construction and renovation, weather file, climate zone and Energy Star Target Finder score.		MEC
			Final Design	Option 1: Space summary listing, for each building use, the conditioned area, unconditioned area and total area and include total area for each category		MEC
			Final Design	Option 1: List of all simulation output advisory message data and show difference between baseline and proposed design		MEC
			Final Design	Option 1: Comparison summary for energy model inputs including description of baseline and design case energy model inputs, showing both by element type		MEC
			Final Design	Option 1: Energy type summary listing, for each energy type, utility rate description, units of energy and units of demand		MEC
			Final Design	Option 1: Statement indicating whether project uses on-site renewable energy. If yes, list all sources and indicate, for each source, backup energy type, annual energy generated, rated capacity and renewable energy cost		MEC
			Final Design	Option 1: If analysis includes exceptional calculation methods, statement describing how exceptional calculation measure cost savings is determined		MEC
			Final Design	Option 1: If analysis includes exceptional calculation methods, for each exceptional calculation method indicate energy types and, for each energy type, annual energy savings, annual cost savings, and brief descriptive narrative		MEC
			Final Design	Option 1: Baseline performance rating compliance report table indicating, for each energy end use, whether it is a process load, energy type, annual and peak energy demand for all four orientations. For each orientation indicate total annual energy use for each orientation and total annual process energy use.		MEC
			Final Design	Option 1: Baseline energy cost table indicating, for each energy type, annual cost for all four orientations and building total energy cost.		MEC
			Final Design	Option 1: Proposed Design performance rating compliance report table indicating, for each energy end use, whether it is a process load, energy type, annual and peak energy demand, baseline annual and peak energy demand and percent savings. Indicate total annual energy use and total annual process energy use for both proposed design and baseline and percent savings.		MEC
			Final Design	Option 1: Proposed Design energy cost table indicating, for each energy type, annual cost for all four orientations and building total energy cost.		MEC
			Final Design	Option 1: Energy cost and consumption by energy type report indicating, for each energy type, proposed design and baseline annual use and annual cost, percent savings annual use and annual cost. Indicate for renewable energy annual energy generated and annual cost. Indicate exceptional calculations annual energy savings and annual cost savings. Indicate building total annual energy use, annual energy cost for proposed design and baseline and indicate percent savings annual energy use and annual energy cost.		MEC

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PAR		FEATURE	DUE AT	REQUIRED DOCUMENTATION	DATE	REV
			Final Design	Option 1: Compliance summaries from energy simulation software. If software does not produce compliance summaries provide output summaries and example input summaries for baseline and proposed design supporting data in the tables. Output summaries must include simulated energy consumption by end use and total energy use and cost by energy type. Example input summaries should represent most common systems and must include occupancy, use pattern, assumed envelope component sizes and descriptive features and assumed mechanical equipment types and descriptive features		MEC
			Final Design	Option 1: Energy rate tariff from project energy providers (only if not using LEED Reference Guide default rates)		MEC
EAPR3		Fundamental Refrigerant Management (PREREQUISITE)	Final Design	Statement indicating which option for compliance applies.		MEC
			Final Design	Option 2: Narrative describing phase out plan, including specific information on phase out dates and refrigerant quantities.		MEC
EA1		Optimize Energy Performance	Final Design	Statement indicating which compliance path option applies.		MEC
			Final Design	Option 1: Statement confirming simulation software capabilities and confirming assumptions and methodology.		MEC
			Final Design	Option 1: General information including simulation program, principal heating source, percent new construction and renovation, weather file, climate zone and Energy Star Target Finder score.		MEC
			Final Design	Option 1: Space summary listing, for each building use, the conditioned area, unconditioned area and total area and include total area for each category		MEC
			Final Design	Option 1: List of all simulation output advisory message data and show difference between baseline and proposed design		MEC
			Final Design	Option 1: Comparison summary for energy model inputs including description of baseline and design case energy model inputs, showing both by element type		MEC
			Final Design	Option 1: Energy type summary listing, for each energy type, utility rate description, units of energy and units of demand		MEC
			Final Design	Option 1: Statement indicating whether project uses on-site renewable energy. If yes, list all sources and indicate, for each source, backup energy type, annual energy generated, rated capacity and renewable energy cost		MEC
			Final Design	Option 1: If analysis includes exceptional calculation methods, statement describing how exceptional calculation measure cost savings is determined		MEC
			Final Design	Option 1: If analysis includes exceptional calculation methods, for each exceptional calculation method indicate energy types and, for each energy type, annual energy savings, annual cost savings, and brief descriptive narrative		MEC
			Final Design	Option 1: Baseline performance rating compliance report table indicating, for each energy end use, whether it is a process load, energy type, annual and peak energy demand for all four orientations. For each orientation indicate total annual energy use for each orientation and total annual process energy use.		MEC
			Final Design	Option 1: Baseline energy cost table indicating, for each energy type, annual cost for all four orientations and building total energy cost.		MEC
			Final Design	Option 1: Proposed Design performance rating compliance report table indicating, for each energy end use, whether it is a process load, energy type, annual and peak energy demand, baseline annual and peak energy demand and percent savings. Indicate total annual energy use and total annual process energy use for both proposed design and baseline and percent savings.		MEC
			Final Design	Option 1: Proposed Design energy cost table indicating, for each energy type, annual cost for all four orientations and building total energy cost.		MEC
			Final Design	Option 1: Energy cost and consumption by energy type report indicating, for each energy type, proposed design and baseline annual use and annual cost, percent savings annual use and annual cost. Indicate for renewable energy annual energy generated and annual cost. Indicate exceptional calculations annual energy savings and annual cost savings. Indicate building total annual energy use, annual energy cost for proposed design and baseline and indicate percent savings annual energy use and annual energy cost.		MEC

Friday, July 23, 2010

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			Final Design	Option 1: Compliance summaries from energy simulation software. If software does not produce compliance summaries provide output summaries and example input summaries for baseline and proposed design supporting data in the tables. Output summaries must include simulated energy consumption by end use and total energy use and cost by energy type. Example input summaries should represent most common systems and must include occupancy, use pattern, assumed envelope component sizes and descriptive features and assumed mechanical equipment types and descriptive features		MEC
			Final Design	Option 1: Energy rate tariff from project energy providers (only if not using LEED Reference Guide default rates)		MEC
EA2.1		On-Site Renewable Energy	Final Design	Statement indicating which compliance path option applies.		ELEC
			Final Design	List all on-site renewable energy sources and indicate, for each source, backup energy type, annual energy generated, rated capacity and renewable energy cost. Indicate total annual energy use (all sources), total annual energy cost (all sources) and percent renewable energy cost.		ELEC MEC
			Final Design	Option 1: Indicate, for renewable energy, proposed design total annual energy generated and annual cost.		ELEC MEC
			Final Design	Option 2: Indicate CBECS building type and building gross area. Provide the following CBECS data: median annual electrical intensity, median annual non-electrical fuel intensity, average electric energy cost, average non-electric fuel cost, annual electric energy use and cost, annual non-electric fuel use and cost.		ELEC MEC
			Final Design	Option 2: Narrative describing renewable systems and explaining calculation method used to estimate annual energy generated, including factors influencing performance.		ELEC MEC
EA2.2		On-Site Renewable Energy	Same as EA2.1	Same as EA2.1		ELEC MEC
EA2.3		On-Site Renewable Energy	Same as EA2.1	Same as EA2.1		ELEC MEC
EA3		Enhanced Commissioning	**Final Design	**Owner's Project Requirements document (OPR)		ALL
			**Final Design	**Basis of Design document for commissioned systems (BOD)		ELEC MEC
			**Final Design	**Commissioning Plan		ELEC MEC
			Closeout	Statement confirming all commissioning requirements have been incorporated into construction documents.		PE
			Closeout	**Commissioning Report		PE
			**Final Design	Statement by CxA confirming Commissioning Design Review		
			Closeout	Statement by CxA confirming review of Contractor submittals for compliance with OPR and BOD		PE
			Closeout	**Systems Manual		PE
			Closeout	Statement by CxA confirming completion of O&M staff and occupant training		PE
			Closeout	**Scope of work for post-occupancy review of building operation, including plan for resolution of outstanding issues		PE
			**Predesign	Statement confirming CxA qualifications and contractual relationships relative to work on this project, demonstrating that CxA is an independent third party.		MEC
EA4		Enhanced Refrigerant Management	Final Design	Refrigerant impact calculation table with all building data and calculation values as shown in LEED 2009 Reference Guide Example Calculations		MEC
			Final Design	Narrative describing any special circumstances or explanatory remarks		
			Closeout	X Cut sheets highlighting refrigerant data for all HVAC components.		PE
EA5		Measurement & Verification	Closeout	Statement indicating which compliance path option applies.		PE
			Closeout	Measurement and Verification Plan including Corrective Action Plan		PE
			Closeout	**Scope of work for post-occupancy implementation of M&V plan including corrective action plan.		PE
EA6		Green Power	Closeout	Statement indicating which compliance path option applies.		PE
			Closeout	Option 1: Indicate proposed design total annual electric energy usage		PE
			Closeout	Option 2: Indicate actual total annual electric energy usage		PE
			Closeout	Option 3: Calculation indicating building type, total gross area, median electrical intensity and annual electric energy use		PE

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			Closeout	Green power provider summary table indicating, for each purchase type, provider name, annual quantity green power purchased and contract term. Indicate total annual green power use and indicate percent green power		PE
			Closeout	Narrative describing how Green Power or Green Tags are purchased		PE
CATEGORY 4 – MATERIALS AND RESOURCES						
MRPR1		Storage & Collection of Recyclables (PREREQUISITE)	Final Design	Statement confirming that recycling area will accommodate recycling of plastic, metal, paper, cardboard and glass. Narrative indicating any other materials addressed and coordination with pickup.		ARC
MR1.1		Building Reuse: Maintain 55% of Existing Walls, Floors & Roof	**Final Design	If project includes a building addition, confirm that area of building addition does not exceed 2x the area of the existing building.		ARC
			**Final Design	Spreadsheet listing, for each building structural/envelope element, the existing area and reused area. Total percent reused.		ARC
MR1.2		Building Reuse: Maintain 75% of Existing Walls, Floors & Roof	Same as MR1.1	Same as MR1.1		ARC
MR1.3		Building Reuse: Maintain 95% of Existing Walls, Floors & Roof	Same as MR1.1	Same as MR1.1		ARC
MR1.4		Building Reuse: Maintain 50% of Interior Non-Structural Elements	**Final Design	If project includes a building addition, confirm that area of building addition does not exceed 2x the area of the existing building.		ARC
			**Final Design	Spreadsheet listing, for each building interior non-structural element, the existing area and reused area. Total percent reused.		ARC
MR2.1		Construction Waste Management: Divert 50% From Disposal	**Preconstruction	Waste Management Plan		PE
			**Construction Quarterly and Closeout	Spreadsheet calculations indicating material description, disposal/diversion location (or recycling hauler), weight, total waste generated, total waste diverted, diversion percentage		PE
			**Construction Quarterly and Closeout	Receipts/tickets for all items on spreadsheet		PE
MR2.2		Construction Waste Management: Divert 75% From Disposal	Same as MR2.1	Same as MR2.1		PE
MR3.1		Materials Reuse: 5%	Closeout	Statement indicating total materials value and whether default or actual.		PE
			Closeout	Spreadsheet calculations indicating, for each reused/salvaged material, material description, source or vendor, cost. Total reused/salvaged materials percentage.		PE
MR3.2		Materials Reuse: 10%	Same as MR3.1	Same as MR3.1		PE
MR4.1		Recycled Content: 10% (post-consumer + 1/2 pre-consumer)	Closeout	Statement indicating total materials value and whether default or actual.		PE
			Closeout	Spreadsheet calculations indicating, for each recycled content material, material name/description, manufacturer, cost, post-consumer recycled content percent, pre-consumer recycled content percent, source of recycled content data. Total post-consumer content materials cost, total pre-consumer content materials cost, total combined recycled content materials cost, recycled content materials percentage.		PE
			Final Design or NLT Preconstruction	**Purchasing Plan consisting of spreadsheet indicated above, filled in with estimated quantities to show strategy for achieving goal.		PE
			Closeout	X Manufacturer published product data or certification, confirming recycled content percentages in spreadsheet		PE
MR4.2		Recycled Content: 20% (post-consumer + 1/2 pre-consumer)	Same as MR4.1	Same as MR4.1		PE
MR5.1		Regional Materials: 10% Extracted, Processed & Manufactured Regionally	Closeout	Statement indicating total materials value and whether default or actual.		PE
			Closeout	Spreadsheet calculations indicating, for each regional material, material name/description, manufacturer, cost, percent compliant, harvest distance, manufacture distance, source of manufacture and harvest location data. Total regional materials cost, regional materials percentage.		PE
			Preconstruction	**Purchasing Plan consisting of spreadsheet indicated above, filled in with estimated quantities to show strategy for achieving goal.		PE
			Closeout	X Manufacturer published product data or certification confirming regional material percentages in spreadsheet		PE

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PAR		FEATURE	DUE AT		REQUIRED DOCUMENTATION	DATE	REV	
MR5.2		Regional Materials:20% Extracted, Processed & Manufactured Regionally	Same as MR5.1		Same as MR5.1		PE	
MR6		Rapidly Renewable Materials	Closeout		Statement indicating total materials value and whether default or actual.		PE	
			Closeout		Spreadsheet calculations indicating, for each rapidly renewable material, material name/description, manufacturer, cost, rapidly renewable content percent, rapidly renewable product value. Total rapidly renewable product value, rapidly renewable materials percentage.		PE	
			Final Design		**Purchasing Plan consisting of spreadsheet indicated above, filled in with estimated quantities to show strategy for achieving goal.		ARC	
			Closeout	X	Manufacturer published product data or certification confirming rapidly renewable material percentages in spreadsheet		PE	
MR7		Certified Wood	Closeout		Statement indicating total materials value and whether default or actual.		PE	
			Closeout		Spreadsheet calculations indicating, for each certified wood material, material name/description, vendor, cost, wood component percent, certified wood percent of wood component, FSC chain of custody certificate number. Total certified wood product value, certified wood materials percentage.		PE	
			Final Design or NLT Preconstruction		**Purchasing Plan consisting of spreadsheet indicated above, filled in with estimated quantities to show strategy for achieving goal.		PE	
			Closeout	X	Vendor invoices, FSC chain of custody certificates and anufacturer published product data or certification confirming all certified wood materials percentages in spreadsheet.		PE	
INDOOR ENVIRONMENTAL QUALITY								
EQPR1		Minimum IAQ Performance (PREREQUISITE)	Final Design		Statement indicating which option for compliance applies, stating applicable criteria/requirement, and confirming that project has been designed to meet the applicable requirements.		MEC	
			Final Design		Narrative describing the project's ventilation design, including specifics about fresh air intake volumes and special considerations.		MEC	
EQPR2		Environmental Tobacco Smoke (ETS) Control (PREREQUISITE)	Final Design		Statement indicating which option for compliance applies, stating applicable criteria/requirement, and confirming that project has been designed to meet the applicable requirements.		ARC	
			Final Design		List of drawing and specification references that convey conformance to applicable requirements (signage, exhaust system, room separation details, etc).		ARC	
EQ1		Outdoor Air Delivery Monitoring	Final Design		Statement indicating which option for compliance applies and confirming that project has been designed to meet the applicable requirements.		MEC	
			Final Design		List of drawing and specification references that convey conformance to applicable requirements.		MEC	
			Final Design		Narrative describing the project's ventilation design and CO2 monitoring system, including specifics about monitors, operational parameters and setpoints.		MEC	
			Closeout	X	Cut sheets for CO2 monitoring system.		PE	
EQ2		Increased Ventilation	Final Design		Statement indicating which option for compliance applies and confirming that project has been designed to meet the applicable requirements.		MEC	
			Final Design		Narrative describing the project's ventilation design, including specifics about zone fresh air intake volumes and demonstrating compliance.		MEC	
			Final Design		Option 2: Narrative describing design method used for determining natural ventilation design, including calculation methodology/model results and demonstrating compliance.		MEC	
			Final Design		List of drawing and specification references that convey conformance to applicable requirements.		MEC	
EQ3.1		Construction IAQ Management Plan: During Construction	**Preconstruction		Construction IAQ Management Plan		PE	
			Closeout		Statement confirming whether air handling units were operated during construction		PE	
			Closeout		Dated jobsite photos showing examples of IAQ management plan practices being implemented. Label photos to indicate which practice they demonstrate. Minimum one photo of each practice at each building.		PE	

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			Closeout	Spreadsheet indicating, for each filter installed during construction, the manufacturer, model number, MERV rating, location installed, and if it was replaced immediately prior to occupancy.		PE
EQ3.2		Construction IAQ Management Plan: Before Occupancy	**Preconstruction	Construction IAQ Management Plan		PE
			Closeout	Statement indicating which option for compliance applies and confirming that required activities have occurred that meet the applicable requirements.		PE
			Closeout	Option 1a: Narrative describing the project's flushout process, including specifics about temperature, airflow and duration, special considerations (if any) and demonstrating compliance.		PE
			Closeout	Option 1b: Narrative describing the project's pre-occupancy and post-occupancy flushout processes, including specifics about temperature, airflow and duration, special considerations (if any) and demonstrating compliance.		PE
			Closeout	Option 2: Narrative describing the project's IAQ testing process, including specifics about contaminants tested for, locations, remaining work at time of test, retest parameters and special considerations (if any).		PE
			Closeout	Option 2: IAQ testing report demonstrating compliance.		PE
EQ4.1		Low Emitting Materials: Adhesives & Sealants	Closeout	Spreadsheet indicating, for each applicable indoor adhesive, sealant and sealant primer used, the manufacturer, product name/model number, VOC content, LEED VOC limit, and source of VOC data.		PE
			Closeout	Spreadsheet indicating, for each applicable indoor aerosol adhesive, the manufacturer, product name/model number, VOC content, LEED VOC limit, and source of VOC data - OR - Statement confirming no indoor aerosol adhesives were used for the project.		PE
			Closeout	Manufacturer published product data or certification confirming material VOCs in spreadsheet		PE
EQ4.2		Low Emitting Materials: Paints & Coatings	Closeout	Spreadsheet indicating, for each applicable indoor paint and coating used, the manufacturer, product name/model number, VOC content, LEED VOC limit, and source of VOC data.		PE
			Closeout	Spreadsheet indicating, for each applicable indoor anti-corrosive/anti-rust paint and coating used, the manufacturer, product name/model number, VOC content, LEED VOC limit, and source of VOC data - OR - Statement confirming no indoor anti-corrosive/anti-rust paints were used for the project .		PE
			Closeout	Manufacturer published product data or certification confirming material VOCs in spreadsheet		PE
EQ4.3		Low Emitting Materials: Flooring Systems	Closeout	Spreadsheet indicating, for each indoor flooring system used, the manufacturer, product name/model number, if it meets LEED requirement (yes/no) and source of LEED compliance data.		PE
			Closeout	Spreadsheet indicating, for each indoor carpet cushion used, the manufacturer, product name/model number, if it meets LEED requirement (yes/no) and source of LEED compliance data - OR - Statement confirming no indoor carpet cushion was used for the project.		PE
			Closeout	Manufacturer published product data or certification confirming material compliance label in spreadsheet		PE
EQ4.4		Low Emitting Materials: Composite Wood & Agrifiber Products	Closeout	Spreadsheet indicating, for each indoor composite wood and agrifiber product used, the manufacturer, product name/model number, if it contains added urea formaldehyde (yes/no) and source of LEED compliance data.		PE
			Closeout	Manufacturer published product data or certification confirming material urea formaldehyde in spreadsheet		PE
EQ5		Indoor Chemical & Pollutant Source Control	Closeout	Spreadsheet indicating, for each permanent entryway system used, the manufacturer, product name/model number and description of system.		PE
			Final Design	List of drawing and specification references that convey locations and installation methods for entryway systems.		ARC
			Final Design	Spreadsheet indicating, for each chemical use area, the room number, room name, description of room separation features (walls, floor/ceilings, openings) and pressure differential from surrounding spaces with doors closed - OR - Statement confirming that project includes no chemical use areas and that no hazardous cleaning materials are needed for building maintenance.		ARC MEC
			Final Design	If project includes chemical use areas: List of drawing and specification references that convey locations of chemical use areas, room separation features and exhaust system.		ARC

Friday, July 25, 2010

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PAR		FEATURE	DUE AT	REQUIRED DOCUMENTATION	DATE	REV
			Final Design	If project includes places where water and chemical concentrate mixing occurs: List of drawing and specification references that convey provisions for containment of hazardous liquid wastes OR - Statement confirming that project includes no places where water and chemical concentrate mixing occurs.		ARC MEC
			Closeout	If project includes chemical use areas: Spreadsheet indicating, for AHUs/mechanical ventilation equipment serving occupied areas, the manufacturer, model number, MERV rating, location installed, and if it was replaced immediately prior to occupancy (yes/no) - OR - Statement confirming that project does not use mechanical equipment for ventilation of occupied areas.		PE
EQ6.1		Controllability of Systems: Lighting	Final Design	Calculation indicating total number of individual workstations, number of workstations with individual lighting controls and the percentage of workstations with individual lighting controls.		ELEC
			Final Design	For each shared multi-occupant space, provide a brief description of lighting controls.		ELEC
			Final Design	Narrative describing lighting control strategy, including type and location of individual controls and type and location of controls in shared multi-occupant spaces.		ELEC
EQ6.2		Controllability of Systems: Thermal Comfort	Final Design	Calculation indicating total number of individual workstations, number of workstations with individual thermal comfort controls and the percentage of workstations with individual thermal comfort controls.		MEC
			Final Design	For each shared multi-occupant space, provide a brief description of thermal comfort controls.		MEC
			Final Design	Narrative describing thermal comfort control strategy, including type and location of individual and shared multi-occupant controls.		MEC
EQ7.1		Thermal Comfort: Design	Final Design	Design criteria spreadsheet indicating, for spring, summer, fall and winter, maximum indoor space design temperature, minimum indoor space design temperature and maximum indoor space design humidity.		MEC
			Final Design	Narrative describing method used to establish thermal comfort control conditions and how systems design addresses the design criteria, including compliance with the referenced standard.		MEC
EQ7.2		Thermal Comfort: Verification	Final Design	Narrative describing the scope of work for the thermal comfort survey, including corrective action plan development		MEC
			Final Design	List of drawing and specification references that convey permanent monitoring system.		MEC
EQ8.1		Daylight & Views: Daylight 75% of Spaces	Final Design	Option 2: Table indicating all regularly occupied spaces with space area and space area with compliant daylight zone. Sum of regularly occupied areas and regularly occupied areas with compliant daylight zone. Percentage calculation of areas with compliant daylight zone to total regularly occupied areas.		ARC
			Final Design	Option 1: Simulation model method, software and output data		ELEC
			Final Design	Option 1: Table indicating all regularly occupied spaces with space area, space area with minimum 25 footcandles daylighting illumination, and method of providing glare control. Sum of regularly occupied areas and regularly occupied areas with 25 fc daylighting. Percentage calculation of areas with 25 fc daylighting to total regularly occupied areas.		ELEC
			Final Design	For all occupied spaces excluded from the calculation, provide narrative indicating reasons for excluding the space.		ARC
			Final Design	List of drawing and specification references that convey exterior glazed opening head and sill heights, glazing performance properties and glare control/sunlight redirection devices.		ARC
			Closeout	Manufacturer published product data or certification confirming glazing Tvis in spreadsheet		PE
EQ8.2		Daylight & Views: Views for 90% of Spaces	Final Design	Table indicating all regularly occupied spaces with space area and space area with access to views. Sum of regularly occupied areas and regularly occupied areas with access to views. Percentage calculation of areas with views to total regularly occupied areas.		ARC
			Final Design	For all occupied spaces excluded from the calculation, provide narrative indicating reasons for excluding the space.		ARC
			Final Design	LEED Floor plan drawings showing line of sight diagramming of views areas in each regularly occupied space. List of drawing/specification references that convey exterior glazed opening head and sill heights.		ARC

INNOVATION & DESIGN PROCESS

Friday, July 23, 2010

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IDc1.1		Innovation in Design	Final Design		Narrative describing intent, requirement for credit, project approach to the credit. List of drawings and specification references that convey implementation of credit. All other documentation that validates claimed credit.		
IDc1.2		Innovation in Design	Final Design				
IDc1.3		Innovation in Design	Final Design				
IDc1.4		Innovation in Design	Final Design				
IDc2		LEED Accredited Professional	Final Design		Narrative indicating name of LEED AP, company name of LEED AP, description of LEED AP's role and responsibilities in the project.		ARC

ATTACHMENT F
Version 02-03-2010

BUILDING INFORMATION MODELING REQUIREMENTS

1.0 Section 1 - Submittal Format

1.1. Design Deliverables. Develop all designs using Building Information Modeling (BIM) and Computer Aided Design (CAD) software. Design submittal drawings shall be 24 x 36 size, suitable for half-size scaled reproduction.

2.0 Section 2 – Design Requirements

2.1. BIM Model and Facility Data. Contractor shall use BIM application(s) and software(s) to develop project designs. "Facility Data" is defined as associated intelligent attribute data. The "Model" is defined as 3D graphics that includes Facility Data and output as described in the paragraph 'Output' below. Contractors will use the Model to produce accurate Construction Documents. For each Center of Standardization (CoS) facility type included in this project, all BIM Models and associated Facility Data shall be submitted in Bentley Systems BIM [Not Supplied - SubmittalReqCADDSystem : BENTLEY_VERSION] with associated USACE Bentley BIM Workspace (which includes specific standard BIM libraries and definitions). This Workspace can be downloaded from the CAD/BIM Technology Center. [Where available, the workspace will be specific to this CoS Facility Standard Design. The Contractor will be provided a baseline multi-discipline BIM Project Model for the CoS Facility Standard Design type, where such a model exists (for the purposes of site adaptation).] The USACE Bentley BIM Workspace is dependent on specific versions of the Bentley BIM suite of products and only the versions of the software that are listed in the Contractor instructions included with the USACE BIM Workspace are permitted to be used.

2.1.1. Reference. Refer to ERDC TR-06-10, "U.S. Army Corps of Engineers Building Information Modeling Road Map" from the CAD/BIM Technology Center website for more information on the USACE BIM implementation goals.

2.2. Drawings. Deliver CAD files used for the creation of the Construction Documents Drawings per requirements in Section 01 33 16, the criteria of the USACE Fort Worth District, and as noted herein. Specification of a CAD file format for these Drawings does not limit which BIM application(s) or software(s) may be used for project development and execution.

2.2.1. IFC Support. The Contractor's selected BIM application(s) and software(s) must support the IFC (Industry Foundation Class - see www.iai-tech.org). Submit any deviations from or additions to the IFC property sets for any new spaces, systems, and equipment for Government approval.

2.2.2. Submittal Requirements. BIM submittals shall be fully interoperable, compatible, and editable with the Bentley BIM tools. Use the specified version of the USACE Bentley BIM Workspace and conform to the requirements of **Sections 3 and 4 below**.

2.2.3. BIM Project Execution Plan.

2.2.3.1. Develop a BIM Project Execution Plan ("Plan" or "PxP") documenting the BIM and analysis technologies selected for the Project Model (integrated with the AEC CAD Standard) from concept development through As-Builts as a design, production, coordination, construction, and documentation tool and the collaborative process by which it shall be executed. See Section 7 for additional guidance on developing the Plan.

2.2.4. BIM Requirements..

2.2.4.1. Facility Data. Develop the Facility Data consisting of a set of intelligent elements for the Model (e.g., doors, air handlers, electrical panels). This Facility Data shall include all material definitions and attributes that are necessary for the Project facility design and construction. Additional data in support of Section 6 Contractor Electives is encouraged.

2.2.4.2. Model Content. The Model and Facility Data shall include, at a minimum, the requirements of Section 4 below.

2.2.4.3. Model Granularity. Models may vary in level of detail for individual elements within a model, but at a minimum must include all features that would be included on a quarter inch (1/4" = 1'0") scaled drawing (e.g. at least 1/16th, 1/8th and 1/4th), or appropriately scaled civil drawings.

2.2.4.4. Output. Submitted CAD drawings (e.g., plans, elevations, sections, schedules, details, etc.) shall be derived (commonly known as extractions, views or sheets) and maintained from the submitted Model and Facility Data.

2.3. Quality Control. Implement quality control (QC) parameters for the Model, including:

2.3.1. Model Standards Checks. QC validation used to ensure that the Project Facility Data set has no undefined, incorrectly defined or duplicated elements. Report non-compliant elements and corrective action plan to correct non-compliant elements. Provide the government with detailed justification and request government approval for any non-compliant element which the contractor proposes to be allowed to remain in the Model.

2.3.2. CAD Standards Checks. QC checking performed to ensure that the fonts, dimensions, line styles, levels and other construction document formatting issues are followed per the A/E/C CADD Standard.

2.3.3. Other Parameters. Develop such other QC parameters as Contractor deems appropriate for the Project and provide to the Government for concurrence.

2.4. Design and Construction Reviews. Perform design and construction reviews at each submittal stage under Section 3 to test the Model, including:

2.4.1. Visual Checks. Checking to ensure the design intent has been followed and that there are no unintended elements in the Model.

2.4.2. Interference Management Checks. Locate conflicting spatial data in the Model where two elements are occupying the same space. Log hard interferences (e.g., mechanical vs. structural or mechanical vs. mechanical overlaps in the same location) and soft interferences, (e.g., conflicts regarding equipment clearance, service access, fireproofing, insulation) in a written report and resolve.

2.4.3. IFC Coordination View. Provide an IFC Coordination View in IFC Express format for all deliverables. Provide exported property set data for all IFC supported named building elements.

2.4.4. Other Parameters. Develop such other Review parameters as the Contractor deems appropriate for the Project and provide to the Government for concurrence..

3.0 Section 3 – Design Stage Submittal Requirements

3.1. General Submittal Requirements.

3.1.1. Provide submittals in compliance with BIM Project Execution Plan deliverables at stages as described hereinafter.

3.1.2. At each Stage in Paragraphs 3.3 through 3.6, provide a Contractor-certified written report confirming that consistency checks as identified in Paragraphs 2.3 and 2.4 have been completed. This report shall be discussed as part of the review process and shall address cross-discipline interferences, if any.

3.1.3. At each Stage in Paragraphs 3.3 through 3.6, provide the Government with:

- The Model, Facility Data, Workspace and CAD Data files in native Bentley BIM/CAD.

- A 3-D interactive review format of the Model in Bentley Navigator, Autodesk Navisworks, Adobe 3D PDF 7.0 (or later), Google Earth KMZ or other format per Plan requirements. The file format for reviews can change between submittals.

- A list of all submitted files. The list should include a description, directory, and file name for each file submitted. For all CAD sheets, include the sheet title and sheet number. Identify files that have been produced from the submitted Model and Facility Data.

3.2. Initial Design Conference Submittal.

3.2.1. Submit a digital copy of the Plan where, in addition to Paragraph 3.1.4, the USACE Geographic District BIM Manager will coordinate with the USACE CoS BIM Manager to confirm acceptability of the Plan or advise as to additional processes or activities necessary to be incorporated.

3.2.2. Within thirty (30) days after the approval of the Plan, conduct a demonstration to review the Plan for clarification, and to verify the functionality of Model technology workflow and processes. If modifications are required, the Contractor shall complete the modifications and resubmit the Plan and perform subsequent demonstration for Government acceptance. There will be no payment for design or construction until the Plan is acceptable to the Government. The Government may also withhold payment for design and construction for unacceptable performance in executing the approved Plan.

3.3. Interim Design Submittals.

3.3.1. BIM and CAD Data. The Model shall include the requirements identified in Paragraph 2.2.4 as applicable to the Interim Design package(s).

3.4. Final Design Submissions and Design Complete Submittals.

3.4.1. BIM and CAD Data. The Model shall include the requirements identified in Paragraph 2.2.4. Acceptance according to Paragraph 3.1.4 is required before commencement of construction, as described in Paragraph 3.7.6 of Section 01 33 16.

3.5. Construction Submittals – Over-The-Shoulder Progress Reviews. Periodic quality control meetings or construction progress review meetings shall include quality control reviews on the implementation and use of the Model, including interference management and design change tracking information.

3.6. Final As-Built BIM and CAD Data Submittal. Submit the final Model, Facility Data, and CAD files reflecting as-built conditions for Government Approval, as specified in Section 01 78 02.00 10, PROJECT CLOSEOUT.

4.0 **Section 4 – BIM Model Minimum Requirements and Output**

4.1. General Provisions. The deliverable Model shall be developed to include the systems described below as they would be built and the processes of installing them, and to reflect final as-built conditions. The deliverable model at the interim design stage and at the final design stage (“released for construction”) shall be developed to include as many of the systems described below as are necessary and appropriate at that design stage.

4.2. Architectural/Interior Design. The Architectural systems Model may vary in level of detail for individual elements, but at a minimum must include all features that would be included on a quarter inch (1/4”=1’0”) scaled drawing. Additional minimum Model requirements include:

4.2.1. Spaces. The Model shall include spaces defining accurate net square footage and net volume, and holding data for the room finish schedule for including room names and numbers. Include Programmatic Information provided by the Government or validated program to verify design space against programmed space, using this information to validate area quantities.

4.2.2. Walls and Curtain Walls. Each wall shall be depicted to the exact height, length, width and ratings (thermal, acoustic, fire) to properly reflect wall types. The Model shall include all walls, both interior and exterior, and the necessary intelligence to produce accurate plans, sections and elevations depicting these design elements.

4.2.3. Doors, Windows and Louvers. Doors, windows and louvers shall be depicted to represent their actual size, type and location. Doors and windows shall be modeled with the necessary intelligence to produce accurate window and door schedules.

4.2.4. Roof. The Model shall include the roof configuration, drainage system, penetrations, specialties, and the necessary intelligence to produce accurate plans, building sections and generic wall sections where roof design elements are depicted.

4.2.5. Floors. The floor slab shall be developed in the structural Model and then referenced by the architectural Model for each floor of the Project building.

4.2.6. Ceilings. All heights and other dimensions of ceilings, including soffits, ceiling materials, or other special conditions shall be depicted in the Model with the necessary intelligence to produce accurate plans, building sections and generic wall sections where ceiling design elements are depicted.

4.2.7. Vertical Circulation. All continuous vertical components (i.e., non-structural shafts, architectural stairs, handrails and guardrails) shall be accurately depicted and shall include the necessary intelligence to produce accurate plans, elevations and sections in which such design elements are referenced.

4.2.8. Architectural Specialties and Woodwork. All architectural specialties (i.e., toilet room accessories, toilet partitions, grab bars, lockers, and display cases) and woodwork (i.e., cabinetry and counters) shall be accurately depicted with the necessary intelligence to produce accurate plans, elevations and sections in which such design elements are referenced.

4.2.9. Signage. The Model shall include all signage and the necessary intelligence to produce accurate plans and schedules.

4.2.10. Schedules. Provide door, window, hardware sets using BHMA designations, flooring, wall finish, and signage schedules from the Model, indicating the type, materials and finishes used in the design.

4.3. Furniture. The furniture systems Model may vary in level of detail for individual elements within a Model, but at a minimum must include all features that would be included on a quarter inch (1/4"=1'0") scaled drawing, and have necessary intelligence to produce accurate plans. Representation of furniture elements is to be 2D. Contractor may provide a minimal number of 3D representations as examples. Examples of furniture include, but are not limited to, desks, furniture systems, seating, tables, and office storage.

4.3.1. Furniture Coordination. Furniture that makes use of electrical, data or other features shall include the necessary intelligence to produce coordinated documents and data.

4.4. Equipment. The Model may vary in level of detail for individual elements within a Model. Equipment shall be depicted to meet layout requirements with the necessary intelligence to produce accurate plans and minimum schedules depicting their configuration. Examples of equipment include but are not limited to copiers, printers, refrigerators, ice machines and microwaves.

4.4.1. Schedules. Provide furniture and equipment schedules from the model indicating the materials, finishes, mechanical, and electrical requirements.

4.5. Structural. The structural systems Model may vary in level of detail for individual elements, but at a minimum must include all features that would be included on a quarter inch (1/4"=1'0") scaled drawing. Additional minimum Model requirements include:

4.5.1. Foundations. All necessary foundation and/or footing elements, with necessary intelligence to produce accurate plans and elevations

4.5.2. Floor Slabs. Structural floor slabs shall be depicted, including all necessary recesses, curbs, pads, closure pours, and major penetrations accurately depicted.

4.5.3. Structural Steel. All steel columns, primary and secondary framing members, and steel bracing for the roof and floor systems (including decks), including all necessary intelligence to produce accurate structural steel framing plans and related building/wall sections.

4.5.4. Cast-in-Place Concrete. All walls, columns, and beams, including necessary intelligence to produce accurate plans and building/wall sections depicting cast-in-place concrete elements.

4.5.5. Expansion/Contraction Joints. Joints shall be accurately depicted.

4.5.6. Stairs. The structural Model shall include all necessary openings and framing members for stair systems, including necessary intelligence to produce accurate plans and building/wall sections depicting stair design elements.

4.5.7. Shafts and Pits. The structural Model shall include all necessary shafts, pits, and openings, including necessary intelligence to produce accurate plans and building/wall sections depicting these design elements.

4.6. Mechanical. The mechanical systems Model may vary in level of detail for individual elements, but at a minimum must include all features that would be included on a quarter inch (1/4"=1'0") scaled drawing. Small diameter (less than 1-1/2" NPS) field-routed piping is not required in the model. Additional minimum Model requirements include:

4.6.1. HVAC. All necessary heating, ventilating, air-conditioning and specialty equipment, including air distribution ducts for supply, return, and ventilation and exhaust ducts, including control system, registers, diffusers, grills and hydronic baseboards with necessary intelligence to produce accurate plans, elevations, building/wall sections and schedules.

4.6.1.1. Mechanical Piping. All necessary piping and fixture layouts, and related equipment, including necessary intelligence to produce accurate plans, elevations, building/wall sections, and schedules.

4.6.2. Plumbing. All necessary plumbing piping and fixture layouts, floor and area drains, and related equipment, including necessary intelligence to produce accurate plans, elevations, building/wall sections, riser diagrams, and schedules.

4.6.3. Equipment Clearances. All HVAC and Plumbing equipment clearances shall be modeled for use in interference management and maintenance access requirements.

4.6.4. Elevator Equipment. The Model shall include the necessary equipment and control system, including necessary intelligence to produce accurate plans, sections and elevations depicting these design elements.

4.7. Electrical/Telecommunications. The electrical systems Model may vary in level of detail for individual elements, but at a minimum must include all features that would be included on a quarter inch (1/4"=1'0") scaled drawing. Small diameter (less than 1-1/2"Ø) field-routed conduit is not required in the model. Additional minimum Model requirements include:

4.7.1. Interior Electrical Power and Lighting. All necessary interior electrical components (i.e., lighting, receptacles, special and general purpose power receptacles, lighting fixtures, panelboards, cable trays and control systems), including necessary intelligence to produce accurate plans, details and schedules. Lighting and power built into furniture/equipment shall be modeled.

4.7.2. Special Electrical Systems. All necessary special electrical components (i.e., security, Mass Notification, Public Address, nurse call and other special occupancies, and control systems), including necessary intelligence to produce accurate plans, details and schedules.

4.7.3. Grounding Systems. Grounding Systems. All necessary grounding components (i.e., lightning protection systems, static grounding systems, communications grounding systems, bonding), including necessary intelligence to produce accurate plans, details and schedules.

4.7.4. Communications. All existing and new communications service controls and connections, both above ground and underground with necessary intelligence to produce accurate plans, details and schedules. Cable tray routing shall be modeled without detail of cable contents.

4.7.5. Exterior Building Lighting. All necessary exterior lighting with necessary intelligence to produce accurate plans, elevations and schedules. The exterior building lighting Model shall include all necessary lighting, relevant existing and proposed support utility lines and equipment required with necessary intelligence to produce accurate plans, details and schedules.

4.7.6. Equipment Clearances. The model shall incorporate and define all electrical and communications working spaces, clearances, and required access

4.8. Fire Protection. The fire protection system Model may vary in level of detail for individual elements, but at a minimum must include all features that would be included on a quarter inch (1/4"=1'0") scaled drawing. Additional minimum Model requirements include:

4.8.1. Fire Protection System. All relevant fire protection components (i.e., branch piping, sprinkler heads, fittings, drains, pumps, tanks, sensors, control panels) with necessary intelligence to produce accurate plans, elevations, building/wall sections, riser diagrams, and schedules. All fire protection piping shall be modeled.

4.8.2. Fire Alarms. Fire alarm/mass notification devices and detection system shall be indicated with necessary intelligence to produce accurate plans depicting them.

4.9. Civil. The civil Model may vary in level of detail for individual elements, but at a minimum must include all features that would be included on a one inch (1"=100') scaled drawing. Additional minimum Model requirements include:

4.9.1. Terrain (DTM). All relevant site conditions and proposed grading, including necessary intelligence to produce accurate Project site topographical plans and cross sections.

4.9.2. Drainage. All existing and new drainage piping, including upgrades thereto, including necessary intelligence to produce accurate plans and profiles for the Project site.

4.9.3. Storm Water and Sanitary Sewers. All existing and new sewer structures and piping, including upgrades thereto, on the Project site with necessary connections to mains or other distribution points as appropriate, including necessary intelligence to produce accurate plans and profiles for the Project site.

4.9.4. Utilities. All necessary new utilities connections from the Project building(s) to the existing or newly-created utilities, and all existing above ground and underground utility conduits, including necessary intelligence to produce accurate plans and site-sections.

4.9.5. Roads and Parking. All necessary roadways and parking lots or parking structures, including necessary intelligence to produce accurate plans, profiles and cross-sections.

5.0 Section 5 - Ownership and Rights in Data

5.1. Ownership. The Government has ownership of and rights at the date of Closeout Submittal to all CAD files, BIM Model, and Facility Data developed for the Project in accordance with FAR Part 27, clauses incorporated in Section 00 72 00, Contract Clauses and Special Contract Requirement 1.14 GOVERNMENT RE-USE OF DESIGN (Section 00 73 00). The Government may make use of this data following any deliverable.

6.0 Section 6 – Contractor Electives

6.1. Applicable Criteria. If the Contractor elected to include one or more of the following features as an elective in its accepted contract proposal for additional credit during the source selection, as described in the proposal submission requirements and evaluation criteria, the following criteria are requirements, as applicable to those elective feature(s).

6.2. COBIE Compliance. The Model and Facility Data for the Project shall fulfill Construction Operations Building Information Exchange (COBIE) requirements as defined by the Whole Building Design Guide organization, including all requirements for the indexing and submission of Portable Document Format (PDF) and other appropriate file formats that would otherwise be printed and submitted in compliance with Project operations and maintenance handover requirements.

6.3. Project Scheduling using the Model. In the BIM Execution Plan and during the Preliminary BIM Execution Plan Review, provide an overview of the use of BIM in the development and support of the project construction schedule.

6.3.1. Submittal Requirements. During the Submittal stages, the Contractor shall deliver the construction schedule with information derived from the Model.

6.3.1.1. Construction Submittals – Over-The-Shoulder Progress Reviews. Periodic quality control meetings or construction progress review meetings shall include quality control reviews on the implementation and use of the Model for project scheduling.

6.4. Cost Estimating. In the BIM Execution Plan and during the Preliminary BIM Execution Plan Review, provide an overview of the use of BIM in the development and support of cost estimating requirements, or other applications such as cost analysis and estimate validation.

6.4.1. Submittal Requirements. During the Submittal stages, the Contractor shall deliver cost estimating information derived from the Model.

6.4.2. Project completion. At project completion, the Contractor shall provide an MII (Micro Computer Aided Cost Estimating System Generation II) Cost Estimate which follows the USACE Cost Engineering Military Work Breakdown System (WBS), a modified Uniformat, to at least the sub-systems level and uses quantity information supplied directly from BIM output to the maximum extent possible, though other "Gap" quantity information will be included as necessary for a complete and accurate cost estimate.

6.4.2.1. Sub system level extracted quantities from the BIM for use within the estimate shall be provided according to how detailed line items or tasks should be installed/built so that accurate costs can be developed and/or reflected. Therefore, when developing a BIM, the designer shall be cognizant of what tasks need to be separated appropriately at the beginning stages of model development, such as tasks done on the first floor versus the same task on higher floors that will be more labor intensive and therefore need to have a separate quantity and be priced differently. Tasks and their extracted quantities from the BIM shall be broken down by their location (proximity in the structure) as well as the complexity of its installation.

6.4.2.2. At all design stages it shall be understood that BIM output as described in this document will not generate all quantities that are necessary in order to develop a complete and accurate cost estimate of the project based on the design. An example of this would be plumbing that is less than 1.5" diameter and therefore not expected to be modeled due to granularity; this information is commonly referred to as The Gap. Quantities from The Gap and their associated costs shall be included in the final project actual cost estimates as well.

6.5. Other Analyses and Reports. Structural, energy and efficiency, EPACT 2005 & EISA 2007, lighting design, daylighting, electrical power, psychrometric processing, shading, programming, LEED, fire protection, code compliance, Life Cycle Cost, acoustic, plumbing.

7.0 Section 7 – BIM Project Execution Plan Template

7.1. Contractors will utilize the latest version of the USACE BIM PROJECT EXECUTION PLAN (USACE PxP) Template to develop an acceptable Plan. The template can be downloaded from the CAD/BIM Technology Center website.

ATTACHMENT G**DESIGN SUBMITTAL DIRECTORY AND SUBDIRECTORY FILE ARRANGEMENT**

Organize electronic design submittal files in a subdirectory/file structure in accordance with the following table. The Contractor may suggest a slightly different structure, subject to the discretion of the government.

Design Submittal Directory and Subdirectory File Arrangement.

Directory	Sub-Directory	Sub-Directory or Files	Files
Submittal/Package Name	Narratives	PDF file or files with updated design narrative for each applicable design discipline	
	Drawings	PDF (subdirectory)	Single PDF file with all applicable drawing sheets - bookmarked by sheet number and name
		BIM (subdirectory) See Attachment F.	BIM project folder (with files) per the USACE Workspace. Include an Excel drawing index file with each drawing sheet listed by sheet #, name and corresponding dgn file name (Final Design & Design Complete only)
	Design Analysis & Calculations	Individual PDF files containing design analysis and calculations for each discipline applicable to the submittal	
		PDF file with Fire Protection and Life Safety Code Review checklist	
	LEED	PDF file with updated Leed Check List	
		PDF file or files with LEED Templates for each point with applicable documentation included in each file.	
		LEED SUBMITTALS	
	Energy Analysis	PDF with baseline energy consumption analysis	
		PDF with actual building energy consumption analysis	
	Specifications	Single PDF file with table of contents and all applicable specifications sections.	
		Submittal Register (Final Design & Design Complete submittal only)	
	Design Quality Control	PDF file or files with DQC checklist(s) and/or statements	
	Building Rendering(s)	PDF file of rendering for each building type included in contract (Final Design & Design Complete).	

**SECTION 01 45 04.00 10
CONTRACTOR QUALITY CONTROL**

1.0 GENERAL

1.1. REFERENCES

1.2. PAYMENT

2.0 PRODUCTS (NOT APPLICABLE)

3.0 EXECUTION

3.1. GENERAL REQUIREMENTS

3.2. QUALITY CONTROL PLAN

3.3. COORDINATION MEETING

3.4. QUALITY CONTROL ORGANIZATION

3.5. SUBMITTALS AND DELIVERABLES

3.6. CONTROL

3.7. TESTS

3.8. COMPLETION INSPECTION

3.9. DOCUMENTATION

3.10. NOTIFICATION OF NONCOMPLIANCE

1.0 GENERAL

1.1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Refer to the latest edition, as of the date of the contract solicitation.

- ASTM INTERNATIONAL (ASTM)
- ASTM D 3740 Minimum Requirements for Agencies
Engaged in the Testing and/or Inspection
of Soil and Rock as Used in Engineering
Design and Construction
- ASTM E 329 Agencies Engaged in the Testing
and/or Inspection of Materials Used in
Construction
- U.S. ARMY CORPS OF ENGINEERS (USACE)
ER 1110-1-12 Quality Management

1.2. PAYMENT

There will be no separate payment for providing and maintaining an effective Quality Control program. Include all costs associated therewith in the applicable unit prices or lump-sum prices contained in the Contract Line Item Schedule.

2.0 PRODUCTS (Not Applicable)

3.0 EXECUTION

3.1. GENERAL REQUIREMENTS

The Contractor is responsible for quality control and shall establish and maintain an effective quality control system in compliance with the Contract Clause titled "Inspection of Construction." The quality control system shall consist of plans, procedures, and organization necessary to produce an end product, which complies with the contract requirements. The system shall cover all design and construction operations, both onsite and offsite, and shall be keyed to the proposed design and construction sequence. The site project superintendent is responsible for the quality of work on the job and is subject to removal by the Contracting Officer for non-compliance with the quality requirements specified in the contract. The site project superintendent in this context shall be the highest level manager responsible for the overall construction activities at the site, including quality and production. The site project superintendent shall maintain a physical presence at the site at all times, except as otherwise acceptable to the Contracting Officer, and shall be responsible for all construction and construction related activities at the site.

3.2. QUALITY CONTROL PLAN

Furnish for Government review, not later than 30 days after receipt of notice to proceed, the Contractor Quality Control (CQC) Plan proposed to implement the requirements of the Contract Clause titled "Inspection of Construction." The plan shall identify personnel, procedures, control, instructions, tests, records, and forms to be used. The Government will consider an interim plan for the first 30 days of operation. Design and construction may begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of work to be started. The Government will not permit work outside of the features of work included in an accepted interim plan to begin until acceptance of a CQC Plan or another interim plan containing the additional features of work to be started. Where the applicable Code issued by the International Code Council calls for an inspection by the Building Official, the Contractor shall include the inspections in the Quality Control Plan and shall perform the inspections. The Designer of Record shall develop a program for any special inspections required by the applicable International Codes and the Contractor shall perform these inspections, using qualified inspectors. Include the special inspection plan in the QC Plan.

3.2.1. Content of the CQC Plan

The CQC Plan shall include, as a minimum, the following to cover all design and construction operations, both onsite and offsite, including work by subcontractors, fabricators, suppliers, and purchasing agents subcontractors, designers of record, consultants, architect/engineers (AE), fabricators, suppliers, and purchasing agents:

3.2.1.1. A description of the quality control organization. Include a chart showing lines of authority and an acknowledgment that the CQC staff shall implement the three phase control system for all aspects of the work specified. A CQC System Manager shall report to the project superintendent or someone higher in the contractor's organization.

3.2.1.2. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function. Also include those responsible for performing and documenting the inspections required by the International Codes and the special inspection program developed by the designer of record.

3.2.1.3. A copy of the letter to the CQC System Manager, signed by an authorized official of the firm, which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop work which is not in compliance with the contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Furnish copies of these letters.

3.2.1.4. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers, and purchasing agents subcontractors, designers of record, consultants, architect engineers (AE), offsite fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

3.2.1.5. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. Use only Government approved Laboratory facilities.

3.2.1.6. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.

3.2.1.7. Procedures for tracking design and construction deficiencies from identification through acceptable corrective action. These procedures shall establish verification that identified deficiencies have been corrected.

3.2.1.8. Reporting procedures, including proposed reporting formats.

3.2.1.9. A list of the definable features of work. A definable feature of work is a task, which is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable feature under a particular section. This list will be agreed upon during the coordination meeting.

3.2.1.10. A list of all inspections required by the International Codes and the special inspection program required by the code and this contract.

3.2.2. Additional Requirements for Design Quality Control (DQC) Plan

The following additional requirements apply to the Design Quality Control (DQC) plan:

3.2.2.1. The Contractor's QCP Plan shall provide and maintain a Design Quality Control (DQC) Plan as an effective quality control program which will assure that all services required by this design-build contract are performed and provided in a manner that meets professional architectural and engineering quality standards. As a minimum, competent, independent reviewers identified in the DQC Plan shall review all documents. Use personnel who were not involved in the design effort to produce the design to perform the independent technical review (ITR). The ITR is intended as a quality control check of the design. Include, at least, but not necessarily limited to, a review of the contract requirements (the accepted contract or task order proposal and amended RFP), the basis of design, design calculations, the design configuration management documentation and check the design documents for

errors, omissions, and for coordination and design integration. The ITR team is not required to examine, compare or comment concerning alternate design solutions but should concentrate on ensuring that the design meets the contract requirements. Correct errors and deficiencies in the design documents prior to submitting them to the Government.

3.2.2.2. Include in the DQC Plan the discipline-specific checklists to be used during the design and quality control of each submittal. Submit these completed checklists at each design phase as part of the project documentation.

3.2.2.3. A Design Quality Control Manager, who has the responsibility of being cognizant of and assuring that all documents on the project have been coordinated, shall implement the DQC Plan. This individual shall be a person who has verifiable engineering or architectural design experience and is a registered professional engineer or architect. Notify the Government, in writing, of the name of the individual, and the name of an alternate person assigned to the position.

3.2.3. Acceptance of Plan

Government acceptance of the Contractor's plan is required prior to the start of design and construction. Acceptance is conditional and will be predicated on satisfactory performance during the design and construction. The Government reserves the right to require the Contractor to make changes in his CQC Plan and operations including removal of personnel, as necessary, to obtain the quality specified.

3.2.4. Notification of Changes

After acceptance of the CQC Plan, notify the Government in writing of any proposed change. Proposed changes are subject to Government acceptance.

3.3. COORDINATION MEETING

After the Postaward Conference, before start of design or construction, and prior to acceptance by the Government of the CQC Plan, the Contractor and the Government shall meet and discuss the Contractor's quality control system. Submit the CQC Plan for review a minimum of 7 calendar days prior to the Coordination Meeting. During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the CQC operations, design activities, control activities, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. The Government will prepare minutes of the meeting for signature by both parties. . The minutes shall become a part of the contract file. There may be occasions when either party will call for subsequent conferences to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures which may require corrective action by the Contractor.

3.4. QUALITY CONTROL ORGANIZATION

3.4.1. Personnel Requirements

The requirements for the CQC organization are a CQC System Manager, a Design Quality Manager, and sufficient number of additional qualified personnel to ensure contract compliance. The CQC organization shall also include personnel identified in the technical provisions as requiring specialized skills to assure the required work is being performed properly. The Contractor's CQC staff shall maintain a presence at the site at all times during progress of the work and have complete authority and responsibility to take any action necessary to ensure contract compliance. The CQC staff shall be subject to acceptance by the Contracting Officer. Provide adequate office space, filing systems and other resources as necessary to maintain an effective and fully functional CQC organization. Promptly furnish complete records of all letters, material submittals, shop drawing submittals, schedules and all other project documentation to the CQC organization. The CQC organization shall be responsible to maintain these documents and records at the site at all times, except as otherwise acceptable to the Contracting Officer.

3.4.2. CQC System Manager

Identify as CQC System Manager an individual within the onsite work organization who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the Contractor. The CQC System

Manager shall be a graduate engineer, graduate architect, or a BA/BS graduate of an ACCE accredited construction management college program. The CQC system Manager may alternately be an engineering technician with at least 2 years of college and an ICC certification as a Commercial Building Inspector (Residential Building Inspector certification will be required for Military Family Housing projects). In addition, the CQC system manager shall have a minimum of 5 years construction experience on construction similar to this contract. The CQC System Manager shall be on the site at all times during construction and shall be employed by the prime Contractor. Assign the CQC System Manager no other duties (except may also serve as Safety and Health Officer, if qualified and if allowed by Section 00 73 00). Identify an alternate for the CQC System Manager in the plan to serve in the event of the System Manager's absence. The requirements for the alternate shall be the same as for the designated CQC System Manager but the alternate may have other duties in addition to serving in a temporary capacity as the acting QC manager.

3.4.3. CQC Personnel

3.4.3.1. In addition to CQC personnel specified elsewhere in the contract provide specialized CQC personnel to assist the CQC System Manager in accordance with paragraph titled Area Qualifications.

3.4.3.2. These individuals may be employees of the prime or subcontractor; be responsible to the CQC System Manager; **are not intended to be full time, but must be physically present at the construction site during work on their areas of responsibility**; have the necessary education and/or experience in accordance with the experience matrix listed herein. These individuals may perform other duties but must be allowed sufficient time to perform their assigned quality control duties as described in the Quality Control Plan. **One person may cover more than one area, provided that they are qualified to perform QC activities for the designated areas below and provided that they have adequate time to perform their duties:**

3.4.4. Experience Matrix

3.4.4.1. Area Qualifications

3.4.4.1.1. Civil - Graduate Civil Engineer or (BA/BS) graduate in construction management with 4 years experience in the type of work being performed on this project or engineering technician with 5 yrs related experience.

3.4.4.1.2. Mechanical - Graduate Mechanical Engineer or (BA/BS) graduate in construction management with 4 yrs related experience or engineering technician with an ICC certification as a Commercial Mechanical Inspector with 5 yrs related experience.

3.4.4.1.3. Electrical - Graduate Electrical Engineer or (BA/BS) graduate in construction management with 4 yrs related experience or engineering technician with an ICC certification as a Commercial Electrical Inspector with 5 yrs related experience.

3.4.4.1.4. Structural - Graduate Structural Engineer or (BA/BS) graduate in construction management with 4 yrs related experience or person with an ICC certification as a Reinforced Concrete Special Inspector and Structural Steel and Bolting Special Inspector (as applicable to the type of construction involved) with 5 yrs related experience.

3.4.4.1.5. Plumbing - Graduate Mechanical Engineer or (BA/BS) graduate in construction management with 4 yrs related experience, or person with an ICC certification as a Commercial Plumbing Inspector with 5 yrs related experience.

3.4.4.1.6. Concrete, Pavements and Soils Materials Technician (present while performing tests) with 2 yrs experience for the appropriate area

3.4.4.1.7. Testing, Adjusting and Balancing Specialist must be a member (TAB) Personnel of AABC or an experienced technician of the firm certified by the NEBB (present while testing, adjusting, balancing).

3.4.4.1.8. Design Quality Control Manager Registered Architect or Professional Engineer (not required on the construction site)

3.4.4.1.9. Registered Fire Protection Engineer with 4 years related experience or engineering technician with 5 yrs related experience (but see requirements for Fire Protection Engineer of Record to witness final testing in Section 01 10 00, paragraph 5.10, Fire Protection).

3.4.4.1.10. QC personnel assigned to the installation of the telecommunication system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification. In lieu of BICSI certification, QC personnel shall have a minimum of 5 years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. QC personnel shall witness and certify the testing of telecommunications cabling and equipment.

3.4.5. Additional Requirement

In addition to the above experience and/or education requirements the CQC System Manager shall have completed the course entitled "Construction Quality Management for Contractors". This course is periodically offered at Geographic District Office. Inquire of the District or Division sponsoring the course for fees and other expenses involved, if any, for attendance at this course.

3.4.6. Organizational Changes

When it is necessary to make changes to the CQC staff, the Contractor shall revise the CQC Plan to reflect the changes and submit the changes to the Contracting Officer for acceptance.

3.5. SUBMITTALS AND DELIVERABLES

Make submittals as specified in Section 01 33 00 **SUBMITTAL PROCEDURES**. The CQC organization shall certify that all submittals and deliverables are in compliance with the contract requirements.

3.6. CONTROL

Contractor Quality Control is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. The CQC organization shall conduct at least three phases of control for each definable feature of the construction work as follows:

3.6.1. Preparatory Phase

Perform this phase prior to beginning work on each definable feature of work, after all required plans/documents/materials are approved/accepted, and after copies are at the work site. This phase shall include:

3.6.1.1. A review of each paragraph of applicable specifications, reference codes, and standards. Make a copy of those sections of referenced codes and standards applicable to that portion of the work to be accomplished in the field at the preparatory inspection. Maintain these copies in the field, available for use by Government personnel until final acceptance of the work.

3.6.1.2. A review of the contract drawings.

3.6.1.3. A check to assure that all materials and/or equipment have been tested, submitted, and approved.

3.6.1.4. Review of provisions that have been made to provide required control inspection and testing.

3.6.1.5. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the contract.

3.6.1.6. A physical examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.

3.6.1.7. A review of the appropriate activity hazard analysis to assure safety requirements are met.

3.6.1.8. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of work.

3.6.1.9. A check to ensure that the portion of the plan for the work to be performed has been accepted by the Contracting Officer.

3.6.1.10. Discussion of the initial control phase.

3.6.1.11. Notify the Government at least 24 hours in advance of beginning the preparatory control phase. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. Document the results of the preparatory phase actions by separate minutes prepared by the CQC System Manager and attached to the daily CQC report. The Contractor shall instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

3.6.2. Initial Phase

Accomplish this phase at the beginning of a definable feature of work. Include the following actions:

3.6.2.1. Check work to ensure that it is in full compliance with contract requirements. Review minutes of the preparatory meeting.

3.6.2.2. Verify adequacy of controls to ensure full contract compliance. Verify required control inspection and testing.

3.6.2.3. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with required sample panels as appropriate.

3.6.2.4. Resolve all differences.

3.6.2.5. Check safety to include compliance with and upgrading of the Accident Prevention plan and activity hazard analysis. Review the activity analysis with each worker.

3.6.2.6. Notify the Government at least 24 hours in advance of beginning the initial phase. The CQC System Manager shall prepare and attach to the daily CQC report separate minutes of this phase. Indicate exact location of initial phase for future reference and comparison with follow-up phases.

3.6.2.7. Repeat the initial phase any time acceptable specified quality standards are not being met.

3.6.3. Follow-up Phase

Perform daily checks to assure control activities, including control testing, are providing continued compliance with contract requirements, until completion of the particular feature of work. The checks shall be made a matter of record in the CQC documentation. Conduct final follow-up checks and correct deficiencies prior to the start of additional features of work which may be affected by the deficient work. Do not build upon nor conceal non-conforming work.

3.6.4. Additional Preparatory and Initial Phases

Conduct additional preparatory and initial phases on the same definable features of work if: the quality of on-going work is unacceptable; if there are changes in the applicable CQC staff, onsite production supervision or work crew; if work on a definable feature is resumed after a substantial period of inactivity; or if other problems develop.

3.7. TESTS

3.7.1. Testing Procedure

Perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements and project design documents. Upon request, furnish to the Government

duplicate samples of test specimens for possible testing by the Government. Testing includes operation and/or acceptance tests when specified. The Contractor shall procure the services of a Corps of Engineers approved testing laboratory, or establish an approved testing laboratory at the project site. The Contractor may elect to use a laboratory certified and accredited by the Concrete and cement Reference Laboratory (CCRL) or by AASHTO Materials Reference Laboratory (AMRL) for testing procedures that those organizations certify. The Contractor shall perform the following activities and record and provide the following data:

3.7.1.1. Verify that testing procedures comply with contract requirements and project design documents.

3.7.1.2. Verify that facilities and testing equipment are available and comply with testing standards.

3.7.1.3. Check test instrument calibration data against certified standards.

3.7.1.4. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.

3.7.1.5. Include results of all tests taken, both passing and failing tests, recorded on the CQC report for the date taken. Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test. If approved by the Contracting Officer, actual test reports may be submitted later with a reference to the test number and date taken. Provide an information copy of tests performed by an offsite or commercial test facility directly to the Contracting Officer. Failure to submit timely test reports as stated may result in nonpayment for related work performed and disapproval of the test facility for this contract.

3.7.2. Testing Laboratories

3.7.2.1. Capability Check

The Government reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt, and steel shall meet criteria detailed in ASTM D 3740 and ASTM E 329.

3.7.2.2. Capability Recheck

If the selected laboratory fails the capability check, the Government will assess the Contractor a charge of \$1,375 to reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the contract amount due the Contractor.

3.7.3. Onsite Laboratory

The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests, and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

3.7.4. Furnishing or Transportation of Samples for Government Quality Assurance Testing

The Contractor is responsible for costs incidental to the transportation of samples or materials. Deliver samples of materials for test verification and acceptance testing by the Government to the Corps of Engineers Laboratory, f.o.b., at the following address:

- For delivery by mail:
 - N/A
 - N/A
 - N/A
 - N/A
- For other deliveries:
 - N/A

N/A

N/A

N/A

The area or resident office will coordinate, exact delivery location, and dates for each specific test.

3.8. COMPLETION INSPECTION

3.8.1. Punch-Out Inspection

Near the end of the work, or any increment of the work established by a time stated in the SPECIAL CONTRACT REQUIREMENTS Clause, "Commencement, Prosecution, and Completion of Work", or by the specifications, the CQC Manager shall conduct an inspection of the work. Prepare a punch list of items which do not conform to the approved drawings and specifications and include in the CQC documentation, as required by paragraph DOCUMENTATION. The list of deficiencies shall include the estimated date by which the deficiencies will be corrected. The CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected. Once this is accomplished, the Contractor shall notify the Government that the facility is ready for the Government Pre-Final inspection.

3.8.2. Pre-Final Inspection

As soon as practicable after the notification above, the Government will perform the pre-final inspection to verify that the facility is complete and ready to be occupied. A Government Pre-Final Punch List may be developed as a result of this inspection. The Contractor's CQC System Manager shall ensure that all items on this list have been corrected before notifying the Government, so that a Final inspection with the customer can be scheduled. Correct any items noted on the Pre-Final inspection in a timely manner. Accomplish these inspections and any deficiency corrections required by this paragraph within the time slated for completion of the entire work or any particular increment of the work if the project is divided into increments by separate completion dates.

3.8.3. Final Acceptance Inspection

The Contractor's Quality Control Inspection personnel, plus the superintendent or other primary management person, and the Contracting Officer's Representative shall attend the final acceptance inspection. Additional Government personnel including, but not limited to, those from Base/Post Civil Facility Engineer user groups and major commands may also attend. The Government will formally schedule the final acceptance inspection based upon results of the Pre-Final inspection. Provide notice to the Government at least 14 days prior to the final acceptance inspection and include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final acceptance inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with the contract clause titled "Inspection of Construction".

3.9. DOCUMENTATION

3.9.1. Maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the work of subcontractors and suppliers using government-provided software, QCS (see Section 01 45 01.10). The report includes, as a minimum, the following information:

3.9.1.1. Contractor/subcontractor and their area of responsibility.

3.9.1.2. Operating plant/equipment with hours worked, idle, or down for repair.

3.9.1.3. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.

- 3.9.1.4. Test and/or control activities performed with results and references to specifications/drawings requirements. Identify the applicable control phase (Preparatory, Initial, Follow-up). List deficiencies noted, along with corrective action.
- 3.9.1.5. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications/drawings requirements.
- 3.9.1.6. Submittals and deliverables reviewed, with contract reference, by whom, and action taken.
- 3.9.1.7. Offsite surveillance activities, including actions taken.
- 3.9.1.8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
- 3.9.1.9. Instructions given/received and conflicts in plans and/or specifications.
- 3.9.1.10. Provide documentation of design quality control activities. For independent design reviews, provide, as a minimum, identity of the ITR team, the ITR review comments, responses and the record of resolution of the comments.
- 3.9.2. Contractor's verification statement.

These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. Furnish the original and one copy of these records in report form to the Government daily within 24 hours after the date covered by the report, except that reports need not be submitted for days on which no work is performed. As a minimum, submit one report for every 7 days of no work and on the last day of a no work period. Account for all calendar days throughout the life of the contract. The first report following a day of no work shall be for that day only. The CQC System Manager shall sign and date reports. The report shall include copies of test reports and copies of reports prepared by all subordinate quality control personnel. The Contractor may submit these forms electronically, in lieu of hard copy.

3.10. NOTIFICATION OF NONCOMPLIANCE

The Contracting Officer will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

End of Section 01 45 04.00 10

**SECTION 01 50 02.0006
TEMPORARY CONSTRUCTION FACILITIES**

1.0 OVERVIEW

1.1. GENERAL REQUIREMENTS

1.3. BULLETIN BOARD, PROJECT SIGN, AND PROJECT SAFETY SIGN

1.0 OVERVIEW

1.1. GENERAL REQUIREMENTS

1.1.1. This section contains requirements specifically applicable to this task order. The requirements of Base ID/IQ contract Section 01 50 02 apply to this task order, except as otherwise specified herein.

1.3. BULLETIN BOARD, PROJECT SIGN, AND PROJECT SAFETY SIGN

1.3.1. Bulletin Board (As Specified in Base contract)

1.3.2. Project and Safety Signs (Added to Stress standardization of signs, in the event that the Base ID/IQ Section 01 50 02 does not contain this information)

Erect a project sign and a site safety sign with informational details as provided by the Government at the Post award conference, within 15 days prior to any work activity on project site. Update the safety sign data daily, with light colored metallic or non-metallic numerals. Remove the signs from the site upon completion of the project. Engineer Pamphlet EP 310-1-6a contains the standardized layout and construction details for the signs. It can be found through a GOOGLE Search or try <http://www.usace.army.mil/publications/eng-pamphlets/ep310-1-6a/s-16.pdf>.

End of Section 01 50 02.0006



REQUEST FOR PROPOSAL



APPENDIX-A

GEOTECHNICAL INFORMATION

Report of
Subsurface Exploration, Laboratory Testing,
and Geotechnical Engineering Evaluation
Advance Individual Training Complex – Phase 1
Fort Eustis, Virginia

F&R Project No. 60L-5791

Prepared for:

DJG, Inc.
449 McLaws Circle
Williamsburg, Virginia 23185

Attention: Dan DeYoung, P.E.

Prepared by:

Froehling & Robertson, Inc.
3015 Dumbarton Road
Richmond, Virginia 23228

January 2010

Friday, July 23, 2010



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F&R Project No. 60L-5791

January 12, 2010

DJG, Inc.
449 McLaws Circle
Williamsburg, Virginia 23185

Attention: Dan DeYoung, P.E.

Subject: Advanced Individual Training (AIT) Complex – Phase 1
Fort Eustis, Virginia

Dear Mr. DeYoung:

Froehling & Robertson, Inc. (F&R) is pleased to present the results of the subsurface exploration program and geotechnical engineering analyses undertaken in connection with the above referenced project. Our services were performed in general accordance with our No. 6010-379G dated December 2, 2009. The attached report presents our understanding of the project, reviews our exploration procedures, describes existing site and general subsurface conditions, and presents our evaluations, conclusions, and recommendations.

We have enjoyed working with you on this project, and we are prepared to assist you with the recommended quality assurance monitoring and testing services during construction. Please contact us if you have any questions regarding this report or if we may be of further service.

Sincerely,
FROEHLING & ROBERTSON, INC.

Brian Bucek, E.I.T.
Geotechnical Engineering Staff

Reviewed by: Donald J. Sipher, P.E.
Senior Geotechnical Engineer

Distribution: Addressee (1 copy + 1 Adobe PDF via email)

F:\PROJECTS L60\60L-5791 (DJG, Inc. - Fort Eustis AIT Phase 1)\60L-5791 Report.Doc





TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
1.0 INTRODUCTION.....	1
1.1 PROJECT INFORMATION.....	1
1.2 SCOPE OF SERVICES	1
2.0 SUBSURFACE EXPLORATION PROCEDURES.....	2
3.0 SITE AND SUBSURFACE CONDITIONS	4
3.1 SITE DESCRIPTION	4
3.2 REGIONAL GEOLOGY.....	4
3.3 SUBSURFACE CONDITIONS.....	4
3.3.1 General.....	4
3.3.2 Surficial Soils.....	5
3.3.3 Fill/Possible Fill Soils	5
3.3.4 Alluvial Soils.....	5
3.3.5 Subsurface Water.....	6
4.0 LABORATORY TESTING	6
5.0 DESIGN RECOMMENDATIONS	7
5.1 GENERAL	7
5.2 SHALLOW FOUNDATION DESIGN FOR DINING FACILITY	8
5.3 ESTIMATED SETTLEMENT	8
5.4 DEEP FOUNDATIONS FOR BARRACKS.....	9
5.4.1 Auger Cast Pile Test Program.....	10
5.4.2 Pre-Stressed Concrete Pile Test Program	11
5.5 GROUND FLOOR SLABS	12
5.6 SEISMIC CONSIDERATIONS.....	13
5.7 PAVEMENT DESIGN	13
6.0 CONSTRUCTION RECOMMENDATIONS	15
6.1 SITE PREPARATION.....	15
6.2 SHALLOW FOUNDATION/FLOOR SLAB CONSTRUCTION	16
6.3 PILE CONSTRUCTION CONSIDERATIONS.....	17
6.3.1 Auger Cast Piles	17
6.3.2 Pre-Stressed Concrete Piles	17
6.4 CONSTRUCTION MATERIALS TESTING (CMT) CONSIDERATIONS	18
6.5 CONTROLLED STRUCTURAL FILL	18
6.6 CONSTRUCTION DRAINAGE.....	19
7.0 CONTINUATION OF SERVICES	19
8.0 LIMITATIONS.....	20



APPENDICES

APPENDIX A

ASFE Information about Geotechnical Reports

Site Vicinity Map (Drawing No. 1)

APPENDIX B

Boring Location Plans (Drawing Nos. 2)

Soil Classification Chart

Key to Boring Log Classification

Boring Logs (B-1 through B-5, D-1 through D-4, & P-1 through P-5)

APPENDIX C

Moisture-Density Relationship Curve (1 page)

California Bearing Ratio Test (2 pages)



1.0 INTRODUCTION

1.1 Project Information

Project information was provided by the client. We understand the Advanced Individual Training (AIT) Complex project will consist of at least four phases. This report specifically deals with Phase 1 of the project which includes the construction of a four-story barracks, two-story dining facility and parking lot, as well as the demolition of existing abandoned residential structures on site. Phase 1 of the AIT Complex is located at the northwest corner of the intersection between Marshall Street and Madison Avenue at Fort Eustis, Virginia (see Site Vicinity Map, Drawing No. 1, Appendix A).

We understand that the new four-story barracks will be a masonry building with concrete plank floors having an approximate building footprint of 38,500 square feet (sf). The two-story dining facility building will likely be a steel framed structure having an approximate footprint of 35,500 sf. Preliminary plans show the proposed buildings are to be surrounded by sidewalks and grassy lawn areas. The proposed parking is to be located east of the buildings and will have at least 239 spaces.

Preliminary structural loading information was provided by the client. It is anticipated that wall loads will be about 12 kips/foot for the barracks and column loads are expected to be as much as 200 kips for the dining facility.

1.2 Scope of Services

The purposes of our involvement on this project were as follows: 1) provide general descriptions of the subsurface soil conditions encountered at the boring locations, 2) provide foundation and pavement design recommendations, and 3) comment on geotechnical aspects of the proposed development. To accomplish the above objectives, we undertook the following scope of services:

- 1) Visited the site to observe existing surface conditions and features;
- 2) Coordinated with Miss Utility services for utility clearance;
- 3) Reviewed readily available geologic and subsurface information relative to the project site;
- 4) Executed a geotechnical subsurface exploration program consisting of fourteen (14) Standard Penetration Test (SPT) borings drilled to depths ranging 5 feet to 80 feet below existing site grades;



- 5) Performed laboratory testing on recovered soil samples to ascertain characteristic soil properties for use in foundation and pavement design;
- 6) Evaluated the findings of the test boring data relative to suitable shallow or deep foundation system design, pavement design and earthwork considerations;
- 7) Prepared this written report summarizing our geotechnical engineering work on the project, providing descriptions of the subsurface conditions encountered, providing foundation and pavement design criteria, and discussing geotechnical related aspects of the proposed construction.

Our geotechnical scope of services did not include a survey of boring locations and elevations, quantity estimates, preparation of plans or specifications, detention pond considerations, or the identification and evaluation of wetland and/or other environmental aspects of the project site.

2.0 SUBSURFACE EXPLORATION PROCEDURES

Our geotechnical subsurface exploration program consisted of fourteen (14) test borings designated B-1 through B-5, D-1 through D-4, and P-1 through P-5. Borings B-1 through B-5 were drilled to depths of 25 to 80 feet in the proposed barracks building footprint. Borings D-1 through D-4 were drilled to a depth of 25 feet in the dining facility building footprint. Borings P-1 through P-5 were drilled to a depth of 5 feet in the proposed parking lot.

The exploration was performed December 14 through 17, 2009, at the approximate locations shown on the attached Boring Location Plan (Drawing No. 2, Appendix B). F&R personnel marked the boring locations in the field by measuring distance from existing features indicated on the provided plans. No claim is made as to the accuracy of the information contained in the provided documents. In consideration of the methods used in their determination, the boring locations shown on the attached Boring Location Plan should be considered approximate.

The test borings were performed in accordance with generally accepted practice using a tracked all-terrain vehicle CME-55 rotary drill rig equipped with an automatic hammer. Hollow-stem augers were advanced to pre-selected depths, the center plug was removed, and representative soil samples were recovered with a standard split-spoon sampler (1 3/8 in. ID, 2 in. OD) in general accordance with ASTM D 1586, the Standard Penetration Test. The split-spoon sampler was driven into the soil by freely dropping a weight of 140 pounds from a height



of 30 inches. The number of blows required to drive the split-spoon sampler three consecutive 6-inch increments was recorded, and the blows of the last two increments were summed to obtain the Standard Penetration Resistance (N-value). The N-value provides a general indication of in-situ soil conditions and has been correlated with certain engineering properties of soils.

The test borings were advanced through the soil overburden to depths ranging 5 feet to 80 feet below the existing site grades. Subsurface water level readings were taken in each of the test borings immediately upon completion of the drilling process. Upon completion of drilling, the boreholes were backfilled with auger cuttings (soil). Periodic observation and maintenance of the boreholes should be performed to monitor for subsidence at the ground surface, as the borehole backfill could settle over time.

Representative soil samples recovered in the field were placed in glass jars and transported to our laboratory for classification and further testing. A member of our geotechnical staff visually classified each split-spoon soil sample on the basis of texture and plasticity in general accordance with the Unified Soil Classification System (USCS) (ASTM D2487) and/or the Visual-Manual Procedure (ASTM D 2488). The group symbol for each soil type, based on the USCS, is indicated in the parentheses following the soil description on the boring logs. The geotechnical engineer grouped the various soil types into zones noted on the boring log. The stratification lines designating the interfaces between earth materials on the boring log are approximate; in situ, the transitions may be gradual. Copies of our boring logs (soil profiles) and classification procedures are provided in Appendix B.

Split-spoon soil samples recovered on this project will be stored at F&R's office for a period of sixty days. After sixty days, the samples will be discarded unless prior notification is provided to us in writing.



3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Site Description

The proposed AIT Complex - Phase 1 is located at the northwest corner of the intersection between Marshall Street and Madison Avenue at Fort Eustis, Virginia. The site is an abandoned residential area consisting of two-story multiple unit dwellings that are to be razed for the construction of the proposed AIT Complex. Each of the dwelling units are surrounded by grassy lawns, with concrete sidewalks leading to each building's entrance. Mature trees and paved parking areas were also located throughout the complex. All of our borings were located in the grassy lawn areas, outside of existing buildings' footprints.

3.2 Regional Geology

Based on our review of the Geologic Map of Virginia (Virginia Department of Mineral Resources, 1993), the project site is located in the Coastal Plain Physiographic Province of Virginia. The Coastal Plain is characterized by flat land to gently rolling hills and valleys. The Coastal Plain is a wedge of mostly marine sediments that gradually thickens to the east. The site is underlain by the Shirley Formation. Deposits may include light- to dark-gray, bluish-gray, and brown sand, gravel, silt, clay, and peat. Fluvial-estuarine facies comprises (1) a lower pebble to boulder sand overlain by (2) a fine to coarse sand interbedded by peat and clayey silt rich in organic material including tree stumps and leaves, which grades upward to a (3) medium- to thick-bedded, clayey and sandy silt and silty clay.

3.3 Subsurface Conditions

3.3.1 General

The subsurface conditions discussed in the following paragraphs and those shown on the attached boring logs represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. The transitions between different soil strata are usually less distinct than those shown on the boring logs. Sometimes the relatively small sample obtained in the field is insufficient to definitely describe the origin of the subsurface material. In these cases, we qualify our origin descriptions with "possible" before the word describing the material's origin (i.e. possible fill, possible residuum, etc.). Although individual test borings are representative of the subsurface conditions at the boring locations on the dates shown, they are not necessarily indicative of



subsurface conditions at other locations or at other times. Data from the specific test borings are shown on the attached boring logs in Appendix B.

3.3.2 Surficial Soils

Surficial Soil was encountered in all of the borings to depths ranging from 0.2 to 1.0 feet (3 to 12 inches) below the existing ground surface. Surficial Soil is typically a dark-colored soil material containing roots, fibrous matter, and/or other organic components, and is generally unsuitable for engineering purposes. F&R has not performed any laboratory testing to determine the organic content or other horticultural properties of the observed Surficial Soil materials. Therefore, the term Surficial Soil is not intended to indicate a suitability for landscaping and/or other purposes. The Surficial Soil depths provided in this report are based on driller observations and should be considered approximate. We note that the transition from Surficial Soil to underlying materials may be gradual, and therefore the observation and measurement of Surficial Soil depths is subjective. Actual Surficial Soil depths should be expected to vary across the site.

3.3.3 Fill/Possible Fill Soils

Fill/Possible Fill may be any material that has been transported and deposited by man. Materials described as fill/possible fill were encountered in Borings B-1, B-2, B-5, D-3, P-3, B-4 and P-5 and ranged in depths from about 2 to 3.5 feet below existing grades. Sampled fill/possible fill materials were generally described as Sandy Lean or Fat CLAY (CL or CH) or Clayey SAND (SC). Standard penetration resistances (N-values) obtained within the sampled fill material typically ranged from 2 to 7 blows per foot (bpf), with indicating that the encountered fill material was likely placed with a low compactive effort.

3.3.4 Alluvial Soils

Natural alluvial soils were encountered in the test borings below the fill/possible fill and surficial soils extending boring termination depths. Sampled natural alluvial soils consisted of Sandy Lean or Fat CLAYs (CH), Clayey SANDs (SC), Silty SANDs (SM) and Sandy or Clayey SILTs (ML or MH). Standard penetration resistances in the sampled soils ranged from 0 to 30 bpf. These N-values indicate the granular soils (Sands) are very loose to medium dense in relative density and the fine-grained soils (Clays and Silts) are soft to very stiff in consistency.



3.3.5 Subsurface Water

The test borings were monitored during drilling, upon completion of drilling operations and at the end of the work day to obtain short-term subsurface water information. The subsurface water data, obtained during and after our subsurface exploration, have been summarized in the following table. Specific subsurface water data may be found on individual boring logs.

Boring Location	Depth of Boring (Feet)	Subsurface Water Depth While Drilling (Feet)	Subsurface Water Depth at End of Day (Feet)	Cave-in Depth at End of Day (Feet)
B – 1	80.0	Not reported	Not reported	Not reported
B – 2	25.0	16.0	11.0	14.0
B – 3	80.0	Not reported	Not reported	Not reported
B – 4	25.0	15.0	12.5	20.0
B – 5	80.0	Not reported	Not reported	Not reported
D – 1	25.0	15.0	8	22.0
D – 2	25.0	13.0	Not observed	20.0
D – 3	25.0	14.5	12.5	14.0
D – 4	25.0	Not encountered	18	18.0
P – 1	5.0	Not encountered	Not observed	3.0
P – 2	5.0	Not encountered	Not observed	3.0
P – 3	5.0	Not encountered	Not observed	3.0
P – 4	5.0	Not encountered	Not observed	3.0
P – 5	5.0	Not encountered	Not observed	3.0

It should be noted that the location of the subsurface water table could vary by several feet because of seasonal fluctuations in precipitation, evaporation, surface water runoff, local topography, and other factors not immediately apparent at the time of this exploration. Normally, the highest subsurface water levels occur in the late winter and spring and lowest levels occur in the late summer and fall. It should be noted that borehole cave-in often indicates wet and unstable conditions.

4.0 LABORATORY TESTING

Representative soil samples were subjected to Natural Water Content, #200 Sieve Wash, and Atterberg Limits testing to substantiate the visual classifications and assist with the estimation of the soils' pertinent engineering properties. In addition, moisture-density relationship testing using the Standard Proctor method (AASHTO T 99) and California Bearing Ratio (CBR) testing



was performed on a bulk sample from Boring P-3 for use in pavement design recommendations. The results of our laboratory testing are included in the following table:

BORING NO.	SAMPLE DEPTH (FEET)	LIQUID LIMIT/ PLASTICITY INDEX	NATURAL WATER CONTENT (%)	#200 SIEVE WASH	MAXIMUM DRY DENSITY/ OPTIMUM MOISTURE (pcf)/(%)	CBR @ 0.1 inch (soaked)	USCS CLASS.
B – 1	43.5 – 45.0	Non Plastic	36.0	33.2	--	--	SM
B – 3	3.5 – 5.0	43/27	23.5	82.7	--	--	CL
B – 5	18.5 – 20.0	Non Plastic	29.6	20.3	--	--	SM
D – 1	2.0 – 3.5	80/58	33.3	97.7	--	--	CH
D – 3	3.5 – 5.0	70/50	31.4	87.7	--	--	CH
P – 3	Bulk	58/41	24.9	83.0	106.2/19.0	2.2	CH

Classification procedures are further explained in Appendix B.

The Design CBR (DCBR) value was determined by taking two-thirds of the 100% compaction value as obtained in the CBR test, resulting in a DBCR value of 1.5. It should be emphasized that the CBR testing was performed under an ideal and controlled laboratory environment. Actual field conditions during construction could readily reduce subgrade conditions depending on site drainage conditions, traffic loading and frequencies, presence of volume-change soils (such as clays), etc.

5.0 DESIGN RECOMMENDATIONS

5.1 General

The following evaluations and recommendations are based on our observations at the site, interpretation of the field data obtained during this exploration, and our experience with similar subsurface conditions and projects. Soil penetration data have been used to estimate an allowable bearing pressure and associated settlement using established correlations. Subsurface conditions in unexplored locations may vary from those encountered. If structure locations or loadings are changed, we request that we be advised so that we may re-evaluate our recommendations.

Determination of an appropriate foundation system for a given structure is dependent on the proposed structural loads, soil conditions, and construction constraints such as proximity to



other structures, etc. The subsurface exploration aids the geotechnical engineer in determining the soil stratum appropriate for structural support. This determination includes considerations with regard to both allowable bearing pressure and compressibility of the soil strata. In addition, since the method of construction greatly affects the soils intended for structural support, consideration must be given to the implementation of suitable methods of site preparation, fill compaction, and other aspects of construction.

5.2 Shallow Foundation Design for Dining Facility

The proposed dining facility building can be supported on a shallow foundation system (spread footings) bearing on native alluvial soils, on properly placed and compacted structural fill (see Section 6.4, Controlled Structural Fill recommendations).

Shallow spread footings may be designed for an allowable bearing pressure of up to 2,000 pounds per square foot (psf). To reduce the possibility of localized shear failures, spread and strip footings should be a minimum of 3 feet and 2 feet wide, respectively. The exterior footings should bear at least 48 inches below finished grades for shrink-swell considerations.

Unsuitable materials such as buried utilities and or questionable natural soils and/or fill materials may underlie the proposed building area. Unsuitable natural soils or uncontrolled fills must be undercut to 5 lateral feet away from the building pad. Any buried utilities/structures must be removed from the footprint of the building, unless proper utility abandonment is feasible (i.e. cleaning out utility pipe and backfilling with concrete, flowable fill, or concrete). Questionable material should be carefully evaluated during construction to verify its suitability for footing and slab support.

5.3 Estimated Settlement

Based on the boring data, we estimate settlement of the proposed construction for shallow foundation systems due to the anticipated loads of less than 1 inch, with differential settlements of $\frac{1}{2}$ to $\frac{2}{3}$ the estimated total settlement. The magnitude of differential settlements will be influenced by the variation in excavation requirements across the building footprint, the distribution of loads, and the variability of underlying soils.

Our settlement analysis was performed on the basis of structural and grading assumptions discussed in the project information section of this report. Actual settlements experienced by the structure and the time required for these soils to settle will be influenced by undetected



variations in subsurface conditions, actual structural loads, final grading plans, and the quality of foundation construction.

5.4 Deep Foundations for Barracks

Due to the anticipated magnitude of the structural loads, excessive foundation settlement would be expected if the proposed barracks building were to be supported by conventional shallow spread footings bearing in the existing soils. It is therefore recommended that the proposed barracks building be supported by a deep foundation system consisting of either driven pre-stressed concrete piles or auger cast piles.

We have evaluated pile design capacities for 12-inch and 16 inch square pre-stressed concrete piles and 16-inch and 18-inch diameter auger cast piles bearing within the stiff Silts or medium dense sands 50 to 60 feet below existing grade. The results of our analyses are provided in the following table

PILE DESIGN DATA				
Pile Size and Type	Pile Tip Bearing Elevation (feet)	Allowable Axial Compressive Capacity (kips)	Allowable Axial Tensile Capacity (kips)	Allowable Lateral Capacity¹ (kips)
12-inch square Pre-Stressed Concrete	-50	46	11	5
	-55	53	14	5
	-60	60	16	6
16-inch square Pre-Stressed Concrete	-50	81	20	8
	-55	93	25	9
	-60	105	30	10
16-inch diameter Auger Cast Pile	-50	52	32	7
	-55	62	39	7
	-60	74	46	8
18-inch diameter Auger Cast Pile	-50	62	24	8
	-55	74	30	9
	-60	105	48	10
Notes: (1) Lateral capacity based on ¼ inch lateral deflection at pile head.				

Since it is anticipated that finished grades will be at or near existing site grades, negative skin friction (downdrag) has not been considered in our evaluations of pile capacity. If ground floor



elevations are significantly raised, then recommended pile capacities will have to be re-evaluated due to the possible development of negative skin friction. The development of negative skin friction would result in a reduction in the allowable axial compressive capacities that are recommended for this report.

Adequate steel reinforcement design for both tensile and lateral loads is required for each auger cast pile to be constructed.

Individual piles should be spaced a minimum of three pile diameters apart from the center to center of each pile. Settlements associated with individual piles and pile groups are anticipated to be relatively immediate and on the order of ½-inch or less.

5.4.1 Auger Cast Pile Test Program

At least two control piles should be installed to check the installation procedures for the auger cast piles. We recommend that the pile axial compressive capacity be verified by a pile load test. The geotechnical engineer should witness the installation of the test pile/control piles. The load test to verify the pile axial capacity should be performed in accordance with ASTM D 1143, Section 8.1.2 Procedure A: Quick Test. The test pile should be loaded to at least 200% of the allowable design compressive strength as verified by compressive strength tests on grout specimens. In addition, the pile load test should not be performed until after a minimum seven day waiting period following installation of the test pile. Application of the test load should be performed under the direction of the geotechnical engineer.

The auger cast piles should be installed in the presence of the geotechnical engineer or designated representative. Verification of the proper pump pressure and grout volumes should be recorded during the grouting procedure for each pile. Records should also be made for date of installation, size, length of pile and tip elevation for each pile.

Auger cast piles should be constructed by rotating a continuous flight of hollow shaft augers to the specified tip elevation. Pile grout should then be injected into the auger at controlled and carefully monitored pressures. The rate of grout injection and the rate of auger withdrawal should be controlled to maintain a positive grout pressure at all times. The auger should be withdrawn at a smooth, steady constant rate while grout pressures are maintained.

A minimum waiting period of 12 hours should be provided before installing a pile that is within three pile diameters of a previously installed pile. This waiting period is necessary to allow the initial set of the grout to occur prior to the placement of adjacent piles.



Grout pressures should be determined in the field based on the rate of grout injection and control of grout return around the auger. Care should be taken to verify that heaving of existing soil surfaces or damage to completed piles does not occur. Based on our past experience, grout pressures of about 100 psi at the auger and 150 psi at the pump have been successfully used.

Volume measurements of grout during placement should be carefully obtained. In general, the volume of grout placed should exceed the net volume of the pile by about 15%. This increased volume is generally attributed to consolidation of weaker soil zones, as well as some filling of soil voids.

Volume measurements are typically based on a calibration of the grout pump which consists of a determination of the volume of grout that is pumped per pump stroke. This calibration should be performed prior to installation of the piles, under the direction of the geotechnical engineer. Use of a Pile Installation Recorder (PIR), such as the system developed by Pile Dynamics, Inc., by the contractor is recommended.

Grout fluidity (Army Corp of Engineers CRC.C-79), grout temperature and preparation of grout compressive strength specimens (ASTM C109) should be performed during pile installation. Testing should be performed twice daily; in the morning and afternoon.

Potential auger cast-in-place contractors should be allowed to review the soil test boring logs. The contractor selected for the auger cast-in-place pile installation should have at least three years of acceptable experience.

5.4.2 Pre-Stressed Concrete Pile Test Program

A minimum of 15 test piles should be driven at the site within the proposed building area prior to installation of production piles. The purpose of the test piles is to attempt to verify bearing depths, axial compressive capacities, and driving conditions across the site. It is noted that the test piles could be installed at planned permanent pile locations. The test piles should be located to provide coverage over the planned structure area. The test pile locations should be reviewed and approved by the geotechnical engineer of record. The test piles should be at least 5 feet longer than the anticipated pile design length and should be initially driven to the indicated design bearing depth. The geotechnical engineer of record should witness and record the driving resistance of the test piles.



The recommended allowable pile axial compressive capacity (or capacities) should be verified by a pile load test. One load test should be performed on each selected design capacity. The load test should be performed on the test pile as selected by the geotechnical engineer. The load test to verify the pile axial compressive capacity should be performed in accordance with ASTM D 1143, Section 5.1, "Standard Loading Procedure." The test pile should be loaded to 200% of the allowable pile design capacity. The load tests should not be performed until at least 72 hours after initial driving and /or re-striking of the pile selected for testing. Application of the test load should be performed under the direction of the geotechnical engineer. Depending upon the driving records and results of the load tests, some adjustment of the design capacities of bearing depths may be necessary.

To aid in evaluating the axial compressive capacities, dynamic testing with a pile driving analyzer (PDA) should be performed during initial installation and during re-striking of each test pile. The pile hammer used in the test pile program should have sufficient energy to "prove" at least 250% of the allowable pile design capacity. "CAPWAP" analyses should be performed on the PDA measurements obtained from 3 test piles as selected by the geotechnical engineer of record. Depending on the findings of the dynamic testing, the specified pile load test may be deleted at the discretion of the geotechnical engineer of record and upon the approval by the Owner.

5.5 Ground Floor Slabs

A properly constructed slab-on-grade floor is expected to perform adequately on approved existing possible fill materials or natural soils. The slab design should incorporate a minimum four-inch-thickness of positively drained, free-draining stone and a vapor barrier. We recommend that the slab-on-grade be designed for a subgrade reaction modulus of 100 pci. If a vapor barrier is incorporated in the design of building slabs to control moisture migration, the applicable sections of ACI 302.1R should be followed to prevent curling.

If possible, limit under-slab utility trenches. Where these are unavoidable, pressure test the plumbing during construction to minimize the possibility of leaks that may result in foundation soil wetting. Utility trenches not overlain with any load bearing structural components should be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor), or equivalent. Where overlain with load bearing components, a higher degree of compaction or the placement of stone may be warranted.

Proper jointing of the ground floor slab is also essential to minimize cracking. ACI suggests that unreinforced, plain concrete slabs may be jointed at spacings of 24 to 36 times the slab thickness, up to a maximum spacing of 18 feet. Floor slab construction should incorporate isolation joints along



bearing walls and around column locations to allow minor movements to occur without damage. Utility or other construction excavations in the prepared floor subgrade should be backfilled to a controlled fill criterion to provide uniform floor support.

If new fill is placed at the barracks site to raise the grade, a structural slab may need to be considered due to the settlement of the ground surface caused by the weight of the added fill.

5.6 Seismic Considerations

The following Seismic Site Class Definition was established per Section 1613.5.2 of the 2006 International Building Code (IBC). Our scope of services did not include a seismic conditions survey to determine site-specific shear wave velocity information. IBC 2006 provides a methodology for interpretation of Standard Penetration Test resistance values (N-values) to determine a Site Class Definition. However, this method requires averaging N-values over the top 100 feet of the subsurface profile. We note that the test borings for this project were extended to a maximum depth of 80 feet below existing site grades to characterize soils within the zone of influence for anticipated new structural loads.

The available subsurface data from our exploration indicates N-values of 0 to 30 bpf with an average N-value less than 15 bpf. Therefore, and in general accordance with Section 1613.5.2 of the 2006 IBC, a **Site Classification "E"** may be used for further evaluations relative to earthquake load design.

We note that the above provided Site Classification is based on information available at the time this report was written. Should this classification be so onerous to the project cost that further study is warranted, we can perform a site-specific geo-physical survey to attain sufficient detail to refine the project's Seismic Site Class Definition. In our experience in the area, a geo-physical survey has a reasonable chance to provide the data for recommending a Site Classification D.

5.7 Pavement Design

F&R performed CBR tests on a representative soil sample from Boring P-3. The thickness of the pavement section recommended is directly related to the service life, the initial cost of placement, the preparation of the soil subgrade, and the method by which the granular base and the pavement are placed. The following pavement section is designed and evaluated using the AASHTO Guide for Design of Pavement Structures 1993 with the VDOT's "Guidelines for Use of the 1993 AASHTO Pavement Design Procedure" for the design and analysis of pavement structures



based on a performance period of 20 years and a DCBR value of 1.5 based on results from our laboratory testing.

Based on the results of our soil test borings, it appears that, in general, the soils that will be exposed as pavement subgrades will consist of Lean or Fat CLAY (CL or CH). Based on these values, as well as the anticipated soil types and assumed CBR, the following asphalt pavement sections are recommended:

Light Duty Asphalt Pavement Automobile Access and Parking Stalls	
Asphalt Surface	Minimum 3 inches Asphalt Surface Material, Type SM-9.5A
Aggregate Base	10.0 inches Aggregate Base Material, Type I, Size 21B, that satisfies VDOT specifications

Heavy Duty Asphalt Pavement Drive Lanes	
Asphalt Surface	Minimum 1.5 inches Asphalt Surface Material, Type SM-9.5A
Asphalt Base Layer	Minimum 4 inches Asphalt Surface Material, Type BM-25.0
Aggregate Base	12.0 inches Aggregate Base Material, Type I, Size 21B, that satisfies VDOT specifications

In areas where heavy truck traffic (i.e., fire and garbage trucks) are anticipated such as dumpster pads, we recommend the use of a Portland Cement Concrete pavement. The concrete provides better support for concentrated wheel loading and also provides resistance to shoving forces by stopping/starting motions of heavy vehicles. We recommend that the pads be constructed of 6 inches of 4000 psi air-entrained concrete underlain by at least 4 inches of compacted stone such as No. 21B.

The final pavement area subgrade (natural soils or engineered fill) should be carefully evaluated by the geotechnical engineer to determine their suitability for pavement support. Evaluation should include, but not be limited to, compaction testing and proofrolling. If encountered in pavement areas, any unsuitable or unstable materials should be undercut and either replaced with engineered fill or re-compacted in accordance with the recommendations of this report.

An important consideration with the design and construction of pavements is surface and subsurface drainage. Where standing water develops, softening of the subgrade and other problems related to the deterioration of the pavement can be expected. Furthermore, good drainage should minimize the possibility of the subgrade materials becoming saturated over a long



time. Surface runoff water that is trapped during construction on the exposed subgrade soils could create localized deterioration of the soil's bearing capacity. Standing water that may develop on the surface of the pavement may be minimized by:

- adequate design (surface graded to control runoff to desired locations - catch basins, drain inlets, gutters, etc.);
- adequate compaction of each lift of pavement section component material (to minimize localized settlements that result in ponding);
- accurate grading of each lift of pavement section component material (to achieve the desired design grades);
- installing temporary weep holes in drainage structures, construction of drainage swales and diversion ditches, and proper backfill and grading behind curbs to minimize water intrusion from behind the curbs.

Pavement subgrades should be constructed and/or prepared in accordance with the recommendations provided in Section 6.0 of this report.

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 Site Preparation

As part of demolition operations, it is recommended that the existing footings and any other building debris be completely removed from the site. Also prior to construction operations, any existing utilities, unsuitable fill, vegetation, and other deleterious non-soil materials should be stripped or removed from the proposed construction area. During the clearing operations, positive surface drainage should be maintained to prevent the accumulation of water. Underground utilities should be re-routed to locations a minimum of 10 feet outside of the proposed new structure footprint.

After stripping, areas intended to support foundations and new fill should be carefully evaluated by a geotechnical engineer. At that time, proofrolling of the subgrade with a 20- to 30-ton loaded truck or other pneumatic-tired vehicle of similar size and weight should be performed under the observation of the geotechnical engineer. Proofrolling should be performed during a time of good weather and not while the site is wet, frozen, or severely desiccated. The proofrolling observation is an opportunity for the geotechnical engineer to locate inconsistencies intermediate of our boring locations in the existing subgrade where at-grade slab support or new fill placement is proposed.



If the subgrade does not perform well under proofrolling, it may be necessary to stabilize the subgrade. We first recommend that, if possible, the subgrade be allowed to dry by scarification and exposure to the sun and air. If drying does not work, then a drier stable material from other cut portions of the site should be used. As a final alternative, we recommend that a geosynthetic fabric and a crushed aggregate layer be used for stabilization. The crushed aggregate layer should be a clean, well-graded stone with no more than 10 percent passing the No. 200 sieve. The aggregate layer thickness should be determined in the field by a geotechnical engineer based on the subgrade performance at the time of construction. Placement of a geosynthetic fabric in areas in which additional construction excavations (i.e. foundation/utility) will occur may reduce its effectiveness. The excavation may cut the fabric, thus limiting its ability to develop sufficient tensile strength.

6.2 Shallow Foundation/Floor Slab Construction

All foundation subgrades should be observed, evaluated, and verified for the design bearing pressure by the geotechnical engineer after excavation and prior to reinforcement steel placement. If low consistency soils are encountered during foundation construction, localized undercutting and/or in-place stabilization of foundation subgrades will be required. The actual need for, and extent of, undercutting should be based on field observations made by the geotechnical engineer at the time of construction. As mentioned previously, undercutting of soft soils may be required in isolated footing locations based on the results of the soil borings.

Excavations for footings should be made in such a way as to provide bearing surfaces that are firm and free of loose, soft, wet, or otherwise disturbed soils. Foundation concrete should not be placed on frozen or saturated subgrades. If such materials are allowed to remain below foundations, settlements will increase. Foundation excavations should be concreted as soon as practical after they are excavated. If an excavation is left open for an extended period, a thin mat of lean concrete should be placed over the bottom to minimize damage to the bearing surface from weather or construction activities. Water should not be allowed to pond in any excavation.

In a dry and undisturbed state, the subgrade soils at the site will provide suitable subgrade support for fill placement and construction operations. However, when wet, the soil can degrade quickly either with or without disturbance from contractor operations. Therefore, good site drainage should be maintained during earthwork operations to help maintain the stability of the soil. Attempting site work during adverse seasonal conditions will have significant effect on the site work budget, as substantially more undercutting will be required. Ideally, earthwork should be performed during the summer or early fall (typically drier and warmer months).



6.3 Pile Construction Considerations

6.3.1 Auger Cast Piles

Each planned auger cast pile location should be augered to the preplanned depth below existing site grades. All production piles should be installed in the presence of an experienced engineering technician (under the direct supervision of the geotechnical engineer) who should keep a record of each pile's construction. Notes should be made of the date of installation, size, depth of pile, strength grout used, volume of grout placed for each pile and the steel reinforcement placed in the pile. Piles should not vary more than 2% from the plumb position. Pile groups should be constructed from the interior of the group outward to preclude damage to the recent grout placed for the interior piles within the group.

6.3.2 Pre-Stressed Concrete Piles

The pile driving hammer should have an energy appropriate for the pile type being driven and the anticipated driving conditions. A wave equation and drivability evaluation should be performed for the proposed pile hammer utilized for the test and production pile installation. This information should be submitted to the geotechnical engineer for review prior to pile installation.

Pre-augering to a depth of 10 feet below the ground surface should be performed at each pile location to lessen potential pile damage and ground vibrations during installation.

Each pile should be installed by continuous driving with an impact type hammer. All production piles should be installed in the presence of an experienced engineering technician, under the direct supervision of the geotechnical engineer, who should keep a record of the driving resistance of each pile. Notes should be made of the date of driving, type, size and length of the pile, driven depth, pile hammer used, energy rating of the hammer, and blows for each foot of driving for the full length of the pile. The criteria for termination of pile driving is normally a penetration resistance criteria or a required depth of penetration as determined by the geotechnical engineer. The technician should also observe pre-driving handling of the piles to assure that they are not damaged.

(Induced flexural stresses incurred during pick-up and placement of concrete piles should not exceed the allowable bending stresses prescribed for that pile length.)

Vertical piles should not vary more than 2% from the plumb position. Pile groups should be driven from the interior outward to preclude densification and excessively hard driving conditions from



piles within the interior of the group. Previously installed piles should be checked for heave and lateral displacement following driving of adjacent piles.

Based on the bearing stratum soils that were encountered at the site, required driving resistance at the specified pile bearing depth may not be attained upon initial driving of the piles; therefore, “re-striking” of the test/production piles, at the discretion of the geotechnical engineer, should be anticipated during installation. Re-striking of piles should not be performed until at least 24 hours after initial driving to allow soils pore pressures to dissipate.

Additional pile installation recommendations are provided in the Section 5.4 of this report.

6.4 Construction Materials Testing (CMT) Considerations

We recommend that all construction activities, including shallow foundations installation, trenching, and placement of backfill, be observed, and compacted backfill be tested, by a qualified engineering technician working under the supervision of a professional geotechnical engineer to verify that the recommendations presented herein are followed.

6.5 Controlled Structural Fill

Controlled structural fill may be constructed using the non-organic on-site soils, or an off-site borrow having a classification of CL, ML, SC, SM, or better as defined by the Unified Soil Classification System. Other materials may be suitable for use as general controlled structural fill materials and should be individually evaluated by the geotechnical engineer. Controlled structural fill should be free of boulders, organic matter, debris, or other deleterious materials and should have a maximum particle size no greater than 3 inches. Soils classified as CH should not be as structural fill in fill depths 3 feet or shallower. These soils are difficult to moisture condition and pose expansive (shrink-swell) risk to foundation.

Fill materials should be placed in horizontal lifts with maximum height of 8 inches loose measure. New fill should be adequately keyed into stripped and scarified subgrade soils. During fill operations, positive surface drainage should be maintained to prevent the accumulation of water. We recommend that structural fill be compacted to at least 95 percent of the Standard Proctor maximum dry density. In confined areas such as utility trenches, portable compaction equipment and thin lifts of 3 to 4 inches may be required to achieve specified degrees of compaction.



In general, we recommend that the moisture content of fill soils be maintained within three percentage points of the optimum moisture content as determined from the Standard Proctor density test. Generally, we do not anticipate significant problems controlling moistures within fill during periods of dry weather, but moisture control may be difficult during winter months or extended periods of rain. We recommend that the contractor have equipment on site during earthwork for both drying and wetting of fill soils. Attempts to work the soils when wet can be expected to result in deterioration of otherwise suitable soil conditions or of previously placed and properly compacted fill.

Where construction traffic or weather has disturbed the subgrade, the upper 8 inches of soils intended for structural support should be scarified and re-compacted. Each lift of fill should be tested in order to confirm that the recommended degree of compaction is attained.

6.6 Construction Drainage

Subsurface water for the purposes of this report is defined as water encountered below the existing ground surface. Based on the subsurface water data obtained during our exploration program, we do not generally anticipate that subsurface water will be encountered during anticipated earthwork or shallow foundation excavations for the proposed buildings at the site. However, the contractor should be prepared to dewater should water levels vary from those encountered during the drilling program. Fluctuations in subsurface water levels and soil moisture can be anticipated with changes in precipitation, runoff, and season.

7.0 CONTINUATION OF SERVICES

We recommend that we be given the opportunity to review the foundation plan, grading plan, and project specifications when construction documents approach completion. This review evaluates whether the recommendations and comments provided herein have been understood and properly implemented. We also recommend that Froehling & Robertson, Inc. be retained for professional and construction materials testing services during construction of the project. Our continued involvement on the project helps provide continuity for proper implementation of the recommendations discussed herein. These services are not part of the currently authorized scope of services.



8.0 LIMITATIONS

This report has been prepared for the exclusive use of DJG, Inc. or their agent, for specific application to the AIT Complex - Phase 1 located at Fort Eustis, Virginia, in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made. Our conclusions and recommendations are based on design information furnished to us; the data obtained from the previously described subsurface exploration program, and generally accepted geotechnical engineering practice. The conclusions and recommendations do not reflect variations in subsurface conditions which could exist intermediate of the boring locations or in unexplored areas of the site. Should such variations become apparent during construction, it will be necessary to re-evaluate our conclusions and recommendations based upon on-site observations of the conditions.

Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. Therefore, experienced geotechnical engineers should evaluate earthwork, pavement, and foundation construction to verify that the conditions anticipated in design actually exist. Otherwise, we assume no responsibility for construction compliance with the design concepts, specifications, or recommendations.

In the event that changes are made in the design or location of the proposed structure, the recommendations presented in the report shall not be considered valid unless the changes are reviewed by our firm and conclusions of this report modified and/or verified in writing. If this report is copied or transmitted to a third party, it must be copied or transmitted in its entirety, including text, attachments, and enclosures. Interpretations based on only a part of this report may not be valid. This report contains 20 pages of text and the attached appendices.

APPENDIX A

Important Information About Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you — should apply the report for any purpose or project except the one originally contemplated.*

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,

- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time to perform additional study.* Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that

have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

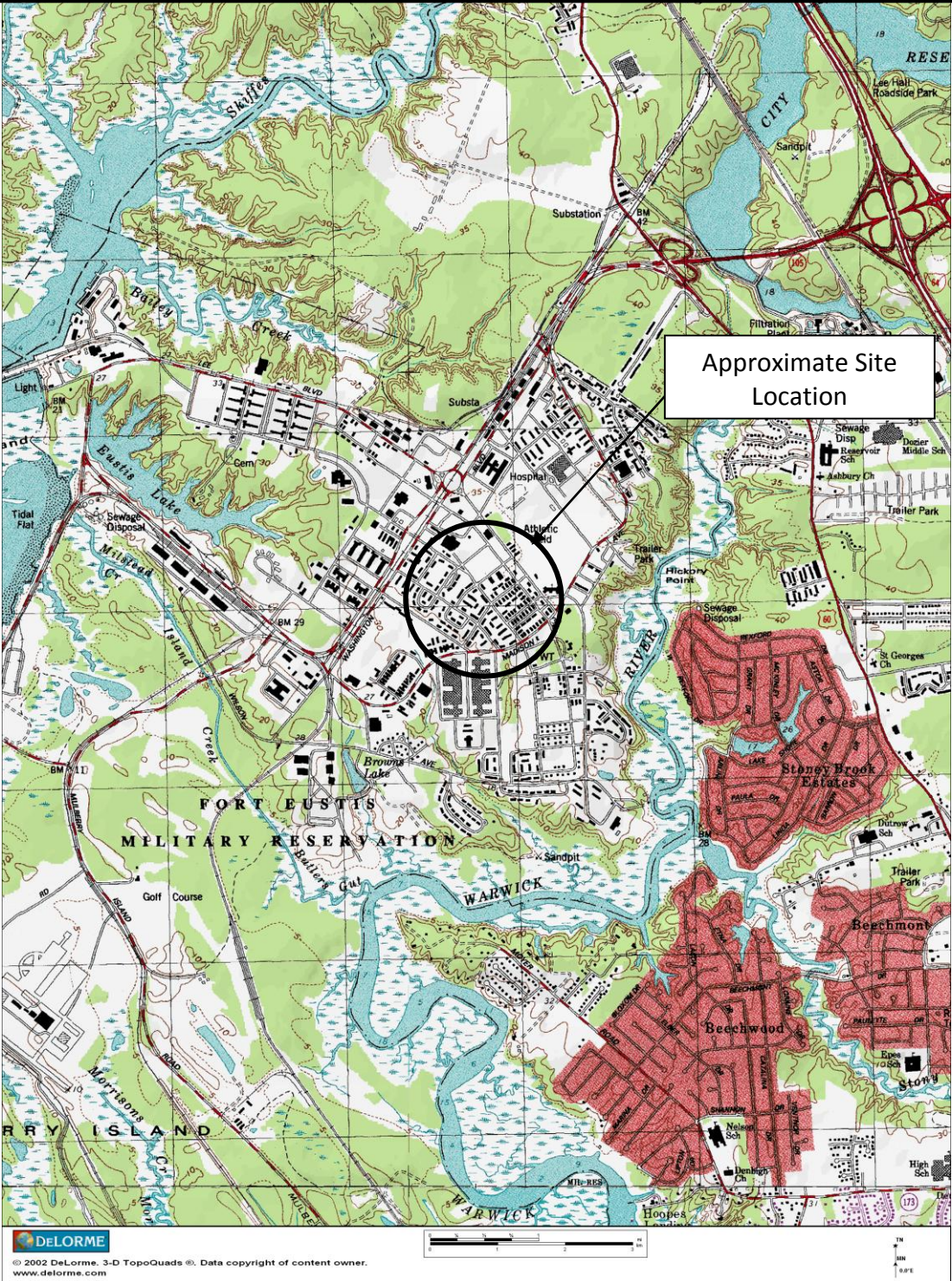
Rely on Your ASFE-Member Geotechnical Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.



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FROEHLING & ROBERTSON, INC
ENGINEERING - ENVIRONMENTAL – GEOTECHNICAL

DATE: January 2010

SOURCE: DeLORME

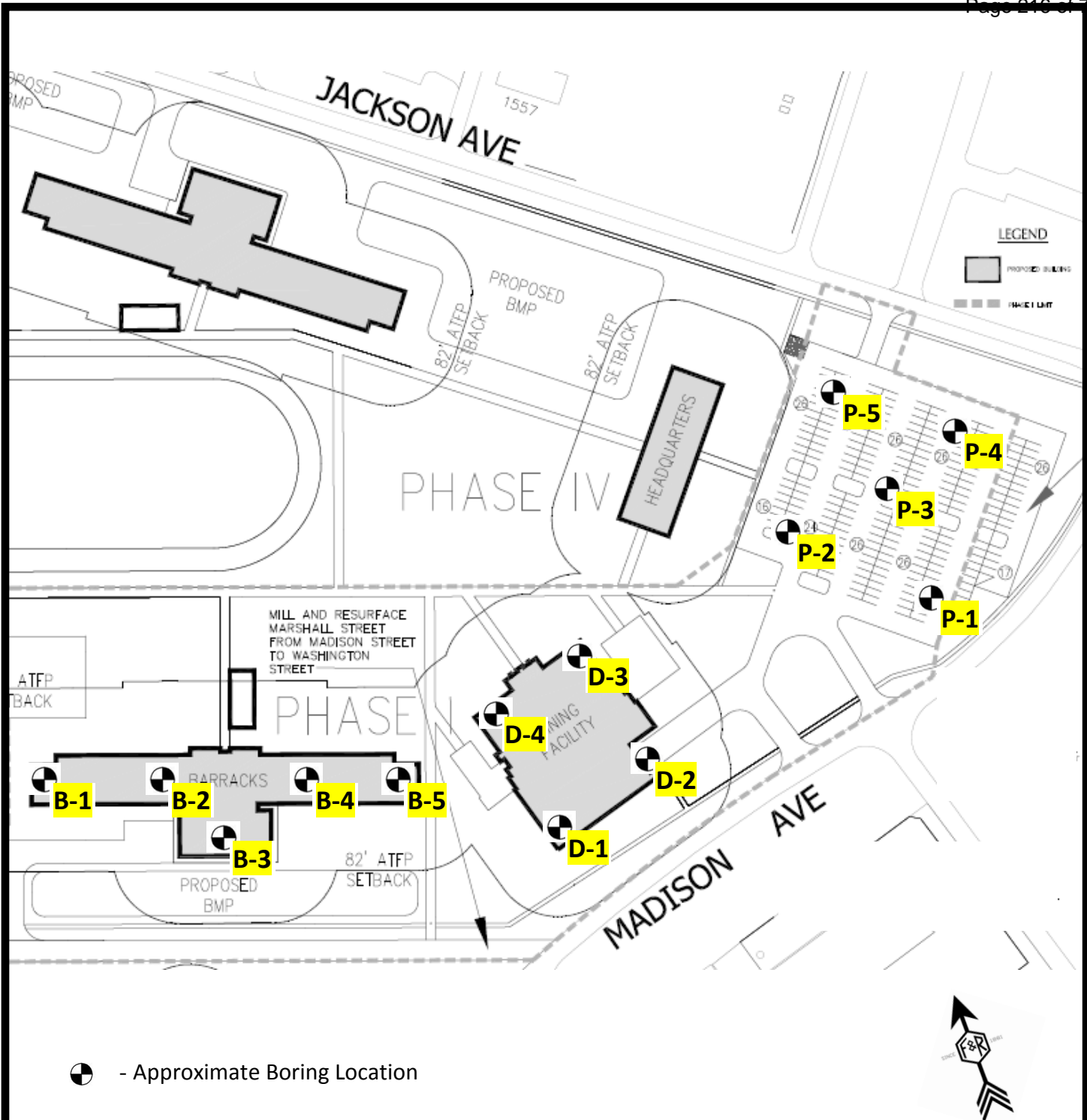
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F&R# 60L-5791

Site Vicinity Map
DJG, Inc.
Advanced Individual Training Complex - Phase 1
Fort Eustis, Virginia

Drawing No.
1

APPENDIX B



FROEHLING & ROBERTSON, INC
ENGINEERING - ENVIRONMENTAL - GEOTECHNICAL

DATE: January 2010

SCALE: N/A

DRAWN: N/A

F&R # 60L-5791

Boring Location Plan
DJG, Inc.
Advanced Individual Training Complex - Phase 1
Fort Eustis, Virginia

Drawing No.

2

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **B-1 (1 of 2)** Total Depth **80.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **Mud Rotary** Started: **12/17/09** Completed: **12/17/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	0.4	Driller Reported "Surficial Soil"	WOH-1-2	0.0		
	2.0	POSSIBLE FILL: Very Loose, Dark Brown, Clayey Fine SAND, with Organic Material - Moist (SC-Possible FILL)	2-2-3	1.5 2.0	3	Groundwater was not reported during drilling
		ALLUVIUM: Firm to Stiff, Yellowish-Brown, Silty Fat CLAY, little Sand - Moist (CH)	3-4-5	3.5 5.0	5 9	Groundwater was not reported upon removal of auger
			1-2-3	6.5		Cave-in depth was not reported
	8.0	Firm to Soft, Yellowish-Brown, Silty Lean CLAY, little Sand - Moist to Wet (CL)	1-2-3	8.0 8.5	5	Driller used automatic hammer to perform SPT
				10.0	5	
			2-2-2	13.5 15.0	4	
	17.0	Loose, Brown, Silty Fine SAND - Wet (SM)				
			2-4-5	18.5 20.0	9	
	22.0	Soft, Greenish-Brown, Silty Fat CLAY, trace Sand - Moist to Wet (CH)	2-1-1	23.5 25.0	2	
	27.0	Firm, Gray, Clayey Elastic SILT, little Sand - Moist to Wet (MH)	2-3-3	28.5 30.0	6	
			1-2-3	33.5 35.0	5	
			2-2-3	38.5 40.0	5	

BORING_LOG 60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil.
The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **B-1 (2 of 2)** Total Depth **80.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **Mud Rotary** Started: **12/17/09** Completed: **12/17/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	42.0	Firm, Gray, Clayey Elastic SILT, little Sand - Moist to Wet				
		(MH)	2-4-5	43.5	9	
		Very Stiff to Stiff, Greenish-Gray, Clayey SILT, trace to little Sand, Most to Wet		45.0		
		(ML)	7-7-10	48.5	17	
				50.0		
			7-12-7	53.5	19	
				55.0		
			5-11-19	58.5	30	
				60.0		
			8-9-11	63.5	20	
				65.0		
	67.0	Soft, Greenish-Gray, Snady Elastic SILT, trace Claye and Shell Fragments, Micaceous - Moist				
		(MH)	1-1-2	68.5	3	
				70.0		
			1-2-2	73.5	4	
				75.0		
			1-1-2	78.5	3	
	80.0	Boring terminated at 80 feet Boring backfilled upon completion		80.0		

BORING_LOG_60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **B-2 (1 of 1)** Total Depth **25.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **HSA 2-1/4" ID** Started: **12/16/09** Completed: **12/16/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	0.3	Driller Reported "Surficial Soil"	1-2-3	0.0		
	2.0	POSSIBLE FILL: Loose, Dark Brown, Clayey Fine SAND, trace Silt, with Organic Material - Moist (SC-Possible FILL)	2-3-5	1.5 2.0	5	Groundwater was encountered at 16 feet during drilling
		ALLUVIUM: Firm to Stiff, Brown, Silty Fat CLAY, trace Sand - Moist	3-4-5	3.5	8	Groundwater was observed at 11 feet upon removal of auger
	5.5	(CH)		5.0	9	
		Medium Dense, Yellowish-Brown, Clayey Fine SAND - Moist	3-7-7	6.5		Cave-in depth at 14 feet
		(SC)		8.0	14	
			5-5-6	8.5		Driller used automatic hammer to perform SPT
				10.0	11	
	13.0	Loose to Medium Dense, Brownish-Gray, Silty Fine SAND - Wet	2-1-4	13.5	5	
		(SM)		15.0		
			1-4-8	18.5		
				20.0	12	
	23.0	Very Loose, Green, Silty Fine to Medium SAND, with Shell Fragments, trace CLAY - Wet	1-1-2	23.5	3	
	25.0	(SM)		25.0		
		Boring terminated at 25 feet Boring backfilled upon completion				

BORING_LOG_60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **B-3 (1 of 2)** Total Depth **80.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **Mud Rotary** Started: **12/16/09** Completed: **12/17/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	0.3	Driller Reported "Surficial Soil"	1-1-4	0.0		
		ALLUVIUM: Firm to Stiff, Brown and Gray, Silty Lean CLAY, trace Sand - Moist (CL)	3-4-6	1.5	5	Groundwater was not reported during drilling
			3-3-3	2.0		
				3.5	10	Groundwater was not reported upon removal of auger
				5.0	6	
	5.5	Loose, Grayish-Brown, Clayey Fine SAND, trace Silt - Moist to Wet (SC)	1-2-4	6.5		Cave-in depth was not reported
				8.0	6	
	8.0	Soft, Grayish-Brown, Sandy Fat CLAY, trace Silt - Moist to Wet (CH)	1-1-2	8.5		Driller used automatic hammer to perform SPT
				10.0	3	
	13.0	Very Loose, Yellowish-Brow, Silty Fine SAND - Wet (SM)	2-2-2	13.5		
				15.0	4	
	18.0	Very Soft, Dark Gray, Silty Fat CLAY, trace Sand - Wet (CH)	WOH-WOH-0	18.5		
		[Faint Organic Odor in Sample]		20.0	0	
	22.0	Firm, Green and Gray, Clayey SILT, trace Sand, with Shell Fragments - Wet (MH)	2-3-3	23.5		
				25.0	6	
			1-2-3	28.5		
				30.0	5	
	32.0	Medium Dense, Greenish-Gray, Silty Fine to Medium SAND, with Shell Fragments, trace Clay - Wet (SM)	2-5-9	33.5		
				35.0	14	
			5-6-8	38.5		
				40.0	14	

BORING LOG 60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **B-3 (2 of 2)** Total Depth **80.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **Mud Rotary** Started: **12/16/09** Completed: **12/17/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
		Firm, Green and Gray, Clayey SILT, trace Sand, with Shell Fragments - Wet (MH)	6-7-9	43.5	16	
				45.0		
			5-7-8	48.5	15	
				50.0		
			4-5-8	53.5	13	
				55.0		
57.0		Stiff, Greenish-Gray, Sandy SILT, with Shell Fragments, trace Clay - Wet (MH)	6-5-7	58.5	12	
				60.0		
62.0		Soft, Greenish-Gray, Sandy SILT, with Shell Fragments, trace Clay - Wet (MH)	2-1-2	63.5	3	
				65.0		
67.0		Soft, Greenish-Gray, Clayey SILT, with Shell Fragments, trace Sand - Wet (MH)	1-1-2	68.5	3	
				70.0		
			2-1-1	73.5	2	
				75.0		
			1-1-2	78.5	3	
80.0				80.0		
		Boring terminated at 80 feet Boring backfilled upon completion				

BORING_LOG 60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil.
The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **B-4 (1 of 1)** Total Depth **25.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **HSA 2-1/4" ID** Started: **12/16/09** Completed: **12/16/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	0.5	Driller Reported "Surficial Soil"	WOH-1-2	0.0		
		ALLUVIUM: Soft to Firm, Brown, Silty Fat CLAY, trace Sand - Moist		1.5	3	Groundwater was encountered at 15 feet during drilling
		(CH)	2-3-4	2.0		
	3.5	Stiff to Firm, Brown and Gray, Silty Fat CLAY, trace Sand - Moist	3-4-6	3.5	7	Groundwater was observed at 12.5 feet upon removal of auger
		(CH)		5.0	10	
			3-5-7	6.5		Cave-in depth at 20 feet
				8.0	12	
			4-4-4	8.5		Driller used automatic hammer to perform SPT
				10.0	8	
	13.0	Very Loose, Brown, Silty Fine to Medium SAND - Moist to Wet	3-2-1	13.5		
		(SM)		15.0	3	
	18.0	Firm, Gray, Sandy SILT, trace Clay - Wet	WOH-1-4	18.5		
		(MH)		20.0	5	
	23.0	Very Loose, Gray, Silty Fine to Medium SAND - Wet	WOH-0-1	23.5		
		(SM)		25.0	1	
	25.0	Boring terminated at 25 feet Boring backfilled upon completion				

BORING_LOG_60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil.
The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **B-5 (1 of 2)** Total Depth **80.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **HSA 2-1/4" ID** Started: **12/15/09** Completed: **12/15/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	0.7	Driller Reported "Surficial Soil"	WOH-1-1	0.0		
	2.0	POSSIBLE FILL: Soft, Brown, Silty Fat CLAY, trace Sand and Roots - Moist (CH-Possible FILL)	2-3-5	1.5 2.0	2	Groundwater was not reported during drilling
		ALLUVIUM: Firm, Brown and Gray, Silty Fat CLAY, trace Sand - Moist (CL)	3-3-5	3.5	8	Groundwater was not reported upon removal of auger
				5.0	8	
			1-2-3	6.5		Cave-in depth was not reported
				8.0	5	
			1-2-3	8.5		Driller used automatic hammer to perform SPT
				10.0	5	
	12.0	Very Soft, Brown, Silty Fat CLAY, trace Sand - Wet (CH)	WOH-0-1	13.5		
				15.0	1	
	17.0	Very Loose, Dark Gray, Silty Fine SAND - Wet (SM)				
			1-2-1	18.5		
				20.0	3	
	23.0	[No Sample Recovery]	WOH-1-3	23.5		
	25.5	Stiff, Dark Gray, Clayey SILT, trace Sand - Moist to Wet (ML)		25.0	4	
			3-5-7	28.5		
				30.0	12	
	32.0	Firm to Stiff, Dark Gray, Clayey SILT, trace Sand - Moist to Wet (MH)	3-3-3	33.5		
				35.0	6	
			1-2-3	38.5		
				40.0	5	

BORING_LOG 60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil.
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Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **B-5 (2 of 2)** Total Depth **80.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **HSA 2-1/4" ID** Started: **12/15/09** Completed: **12/15/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
		Firm to Stiff, Dark Gray, Clayey SILT, trace Sand - Moist to Wet (MH)				
			2-2-4	43.5	6	
				45.0		
			1-4-4	48.5	8	
				50.0		
			4-4-6	53.5	10	
				55.0		
57.0		Medium Dense, Dark Gray, Silty Fine to Medium SAND, with Shell Fragments, trace Clay - Wet (SM)	8-9-9	58.5	18	
				60.0		
62.0		Firm to Soft, Gray, Sandy SILT, with Shell Fragments, trace Clay - Wet (MH)	3-3-3	63.5	6	
				65.0		
			1-1-2	68.5	3	
				70.0		
			1-1-2	73.5	3	
				75.0		
			2-2-3	78.5	5	
				80.0		
80.0		Boring terminated at 80 feet Boring backfilled upon completion				

BORING_LOG 60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil.
The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **D-1 (1 of 1)** Total Depth **25.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **HSA 2-1/4" ID** Started: **12/15/09** Completed: **12/15/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	0.5	Driller Reported "Surficial Soil"	WOH-3-3	0.0		
		ALLUVIUM: Stiff to Firm, Brown and White, Silty Fat CLAY, trace Sand - Moist (CH)	2-4-7	1.5 2.0	6	Groundwater was encountered at 15 feet during drilling
			3-4-8	3.5	11	Groundwater was observed at 8 feet upon removal of auger
	5.5	Stiff to Firm, Brown and Gray, Silty Lean CLAY, trace Sand - Moist (CL)	4-5-6	5.0 6.5	12	Cave-in depth at 22 feet
			2-2-4	8.0 8.5	11	Driller used automatic hammer to perform SPT
				10.0	6	
	12.0	Very Loose, Dark Gray, Silty Fine SAND - Wet (SM)	1-1-2	13.5	3	
				15.0		
	17.0	Soft to Firm, Dark Gray, Sandy SILT, with Shell Fragments, trace Clay - Wet (ML)	1-1-2	18.5	3	
				20.0		
			3-2-4	23.5		
	25.0	Boring terminated at 25 feet Boring backfilled upon completion		25.0	6	

BORING_LOG_60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **D-2 (1 of 1)** Total Depth **25.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **HSA 2-1/4" ID** Started: **12/16/09** Completed: **12/16/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	1.0	Driller Reported "Surficial Soil"	WOH-2-3	0.0		
		ALLUVIUM: Firm to Stiff, Brown to Gray, Silty Fat CLAY, trace to little Sand - Moist (CH)	3-3-6	1.5 2.0	5	Groundwater was encountered at 13 feet during drilling
			2-4-6	3.5	9	Groundwater was not observed upon removal of auger
				5.0	10	
			2-3-4	6.5		Cave-in depth at 20 feet
	8.5	Firm, Brown and Gray, Silty Lean CLAY, with Sand Seams - Moist (CL)	2-3-3	8.0 8.5	7	Driller used automatic hammer to perform SPT
	11.0	Soft, Dark Gray, Sandy Lean CLAY, trace Silt - Moist to Wet (CL)		10.0	6	
			2-1-1	13.5		
				15.0	2	
	17.0	Medium Dense, Dark Gray, Silty Fine SAND - Wet (SM)				
			1-7-8	18.5		
				20.0	15	
	22.0	Firm, Dark Gray, Sandy SILT, with Shell Fragments, trace Clay - Moist to Wet (MH)				
			2-3-4	23.5		
	25.0	Boring terminated at 25 feet Boring backfilled upon completion		25.0	7	

BORING_LOG_60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **D-3 (1 of 1)** Total Depth **25.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **HSA 2-1/4" ID** Started: **12/16/09** Completed: **12/16/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	1.0	Driller Reported "Surficial Soil"	WOH-1-1	0.0		
		POSSIBLE FILL: Soft to Stiff, Brown, Silty Fat CLAY, trace Sand - Moist (CH-Possible FILL)	3-4-5	1.5 2.0	2	Groundwater was encountered at 14.5 feet during drilling
	3.5	ALLUVIUM: Stiff to Firm, Light Gray, Sandy Lean CLAY, trace to little Silt - Moist (CL)	3-5-6	3.5 5.0	9 11	Groundwater was observed at 12.5 feet upon removal of auger
			2-3-4	6.5 8.0 8.5	7	Cave-in depth at 14 feet
			3-3-5	10.0	8	Driller used automatic hammer to perform SPT
	12.0	Loose, Light Gray, Silty Fine to Medium SAND - Wet (SM)	2-3-3	13.5 15.0	6	
	17.0	Medium Dene, Brown, Silty Fine to Coarse SAND - Wet (SM)	3-5-7	18.5 20.0	12	
	22.0	Soft, Dark Gray, Sandy Lean to Fat CLAY, little Silt - Wet (CL)	1-1-1	23.5	2	
	25.0	Boring terminated at 25 feet Boring backfilled upon completion		25.0		

BORING_LOG 60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in the soil.
The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **D-4 (1 of 1)** Total Depth **25.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **HSA 2-1/4" ID** Started: **12/16/09** Completed: **12/16/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	1.0	Driller Reported "Surficial Soil"	WOH-1-1	0.0		
		ALLUVIUM: Soft to Stiff, Brown and Gray, Silty Fat CLAY, trace Sand - Moist (CH)	1-3-3	1.5	2	Groundwater was not encountered during drilling
			2-4-5	2.0		
				3.5	6	Groundwater was observed at 17 feet upon removal of auger
				5.0	9	
			3-3-5	6.5		Cave-in depth at 18 feet
	8.0	Stiff to Firm, Gray and Brown, Sandy Lean CLAY, trace Silt - Moist (CL)	2-3-6	8.0	8	Driller used automatic hammer to perform SPT
				8.5		
				10.0	9	
			2-2-3	13.5		
				15.0	5	
	18.5	Very Soft to Soft, Dark Greenish-Gray, Sandy SILT, with Shell Fragments, trace Clay - Wet (ML)	WOH-0-0	18.5		
				20.0	0	
			WOH-1-2	23.5		
	25.0	Boring terminated at 25 feet Boring backfilled upon completion		25.0	3	

BORING_LOG_60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil.
The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **P-1 (1 of 1)** Total Depth **5.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **HSA 2-1/4" ID** Started: **12/14/09** Completed: **12/14/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	0.3	Driller Reported "Surficial Soil"	1-1-2	0.0		
		ALLUVIUM: Soft to Stiff, Brown and Gray, Silty Fat CLAY, trace Sand - Moist		1.5	3	Groundwater was not encountered during drilling
		(CH)	2-2-4	2.0		
			3-4-5	3.5	6	Groundwater was not observed upon removal of auger
	5.0	Boring terminated at 5 feet Boring backfilled upon completion		5.0	9	Cave-in depth at 3 feet Driller used automatic hammer to perform SPT

BORING_LOG_60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil.
The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **P-2 (1 of 1)** Total Depth **5.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **HSA 2-1/4" ID** Started: **12/14/09** Completed: **12/14/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	0.3	Driller Reported "Surficial Soil"	WOH-2-2	0.0		
		ALLUVIUM: Soft to Firm, Brown, Silty Fat CLAY, trace Sand - Moist		1.5	4	Groundwater was not encountered during drilling
		(CH)	2-2-4	2.0		
	3.5	Firm, Gray, Silty Fat CLAY, trace Sand - Moist	2-3-5	3.5	6	Groundwater was not observed upon removal of auger
	5.0	(CH)		5.0	8	
		Boring terminated at 5 feet Boring backfilled upon completion				Cave-in depth at 3 feet Driller used automatic hammer to perform SPT

BORING_LOG_60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in soil.
The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

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Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **P-3 (1 of 1)** Total Depth **5.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **HSA 2-1/4" ID** Started: **12/14/09** Completed: **12/14/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	0.3	Driller Reported "Surficial Soil"	WOH.-2-1	0.0		
	2.0	FILL: Soft, Dark Brown, Silty Fat CLAY, trace Sand, little Organic Material - Moist (CH-FILL)	3-4-6	1.5 2.0	3	Groundwater was not encountered during drilling
	5.0	ALLUVIUM: Stiff, Brown, Silty Fat CLAY, trace Sand - Moist (CH)	4-6-8	3.5 5.0	10 14	Groundwater was not observed upon removal of auger
		Boring terminated at 5 feet Boring backfilled upon completion				Cave-in depth at 3 feet Driller used automatic hammer to perform SPT

BORING_LOG_60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil.
The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

Engineering • Environmental • Geotechnical

Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **P-4 (1 of 1)** Total Depth **5.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **HSA 2-1/4" ID** Started: **12/14/09** Completed: **12/14/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	0.2	Driller Reported "Surficial Soil"	1-1-1	0.0		
		FILL: Soft to Firm, Dark Brown, Silty Fat CLAY, trace Sand and Gravel, little Organic Material - Moist	4-3-4	1.5 2.0	2	Groundwater was not encountered during drilling
	3.5	(CH-FILL)	1-1-2	3.5	7	Groundwater was not observed upon removal of auger
	5.0	ALLUVIUM: Soft, Brown, Silty Fat CLAY, trace Sand - Moist		5.0	3	
		(CH)				
		Boring terminated at 5 feet Boring backfilled upon completion				Cave-in depth at 3 feet
						Driller used automatic hammer to perform SPT

BORING_LOG_60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil.
The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

BORING LOG**FROEHLING & ROBERTSON, INC.**

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Report No.: **60L-5791**Date: **December 2009**Client: **DJG, Inc.**Project: **AIT Complex - Phase 1, Fort Eustis, Virginia**Boring No.: **P-5 (1 of 1)** Total Depth **5.0'** Elev: Location: **See Boring Location Plan**Type of Boring: **HSA 2-1/4" ID** Started: **12/14/09** Completed: **12/14/09** Driller: **Tignor**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
	0.2	Driller Reported "Surficial Soil"	WOH-1-1	0.0		
	2.0	FILL: Soft, Dark Brown, Silty fat CLAY, trace Gravel and Organic Material - Moist (CH-FILL)	1-3-4	1.5	2	Groundwater was not encountered during drilling
		ALLUVIUM: Firm to Stiff, Brown to Light Gray, Silty Fat CLAY, trace Sand - Moist (CH)	3-5-6	3.0 3.5	7	Groundwater was not observed upon removal of auger
	5.0	Boring terminated at 5 feet Boring backfilled upon completion		5.0	11	Cave-in depth at 3 feet Driller used automatic hammer to perform SPT

BORING_LOG_60L-5791.GPJ F&R.GDT 1/7/10

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches into the soil.
The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

Friday, July 23, 2010

KEY TO BORING LOG SOIL CLASSIFICATIONS

Particle Size and Proportion

Verbal descriptions are assigned to each soil sample or stratum based on estimates of the particle size of each component of the soil and the percentage of each component of the soil.

Particle Size		Proportion/		
Descriptive Terms		Descriptive Terms		
Soil Component	Particle Size	Component	Term	Percentage
Boulder	> 12 inch	Major	Uppercase Letters (e.g., SAND, CLAY)	> 50%
Cobble	3 - 12 inch	Secondary	Adjective (e.g., sandy, clayey)	20%-50%
Gravel-Coarse	3/4 - 3 inch			
-Fine	#4 - 3/4 inch			
Sand-Coarse	#10 - #4			
-Medium	#40 - #10	Minor	Some Little Trace	15%-25% 5%-15% 0%-5%
-Fine	#200 - #40			
Silt (non-cohesive)	< #200			
Clay (cohesive)	< #200			
Notes: 1. Particle size is designated by U.S. Standard Sieve Sizes. 2. Because of the small size of the split-spoon sampler relative to the size of gravel, the true percentage of gravel may not be accurately estimated.				

Density or Consistency

The standard penetration resistance values (N-values) are used to describe the density of coarse-grained soils (GRAVEL, SAND) or the consistency of fine-grained soils (SILT, CLAY). Sandy silts of very low plasticity may be assigned a density instead of a consistency.

DENSITY		CONSISTENCY	
Term	N-Value	Term	N-Value
Very Loose	0 - 4	Very Soft	0 - 1
Loose	5 - 10	Soft	2 - 4
Medium-Dense	11 - 30	Firm	5 - 8
Dense	31 - 50	Stiff	9 - 15
Very Dense	> 50	Very Stiff	16 - 30
		Hard	> 30
Notes: 1. The N-value is the number of blows of a 140 lb. hammer freely falling 30 inches required to drive a standard split spoon sampler (2.0 in. O.D., 1 3/8 in I.D.) 12 inches into the soil after properly seating the sampler six inches. 2. When encountered, gravel may increase the N-value of the standard penetration test and may not accurately represent the in-situ density or consistency of the soil sampled.			

rev. Dec 2001

SOIL CLASSIFICATION CHART - Adapted from ASTM D 2487

MAJOR DIVISIONS		GROUP SYMBOLS	TYPICAL NAMES	CLASSIFICATION CRITERIA						
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve*	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	$C_u = D_{60}/D_{10}$ Greater than 4 $\frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting both criteria for GW	Atterberg limits plot below "A" line and plasticity index greater than 4 Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols				
		GP	Poorly graded gravels and gravel-sand mixtures, little or no fines							
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures						
		GC	Clayey gravels, gravel-sand-clay mixtures							
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines	$C_u = D_{60}/D_{10}$ Greater than 6 $\frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting both criteria for SW	Atterberg limits plot below "A" line and plasticity index less than 4 Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols				
			SP	Poorly graded sands and gravelly sands, little or no fines						
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures						
			SC	Clayey sands, sand-clay mixtures						
			FINE-GRAINED SOILS 50% or more passes No. 200 sieve*	SILTS AND CLAYS Liquid limit 50% or less			ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	PLASTICITY CHART For classification of fine-grained soils and fine fraction of coarse-grained soils. Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols. Equation of A-line: $PI = 0.73 (LL - 20)$	
							CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
OL	Organic silts and organic silty clays of low plasticity									
SILTS AND CLAYS Liquid limit GREATER THAN 50%	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts								
	CH	Inorganic clays of high plasticity, fat clays								
	OH	Organic clays of medium to high plasticity								
	Highly Organic Soils	PT		Peat, muck and other highly organic soils						

*Based on the material passing the 3-in. (75-mm) sieve.

APPENDIX C

COMPACTION TEST REPORT

Curve No.: 1

Project No.: 60L-5791

Date: 1-11-10

Project: AIT Phase 1

Client: DJG, Inc.

Location: Fort Eustis

Sample Number: 1 [Control #111080]

Remarks: N/A

MATERIAL DESCRIPTION

Description: Brownish Silty Clay [Sample Marked S-1 P-3]

Classifications -

USCS: CH

AASHTO:

Nat. Moist. = 24.9 %

Sp.G. =

Liquid Limit = 58

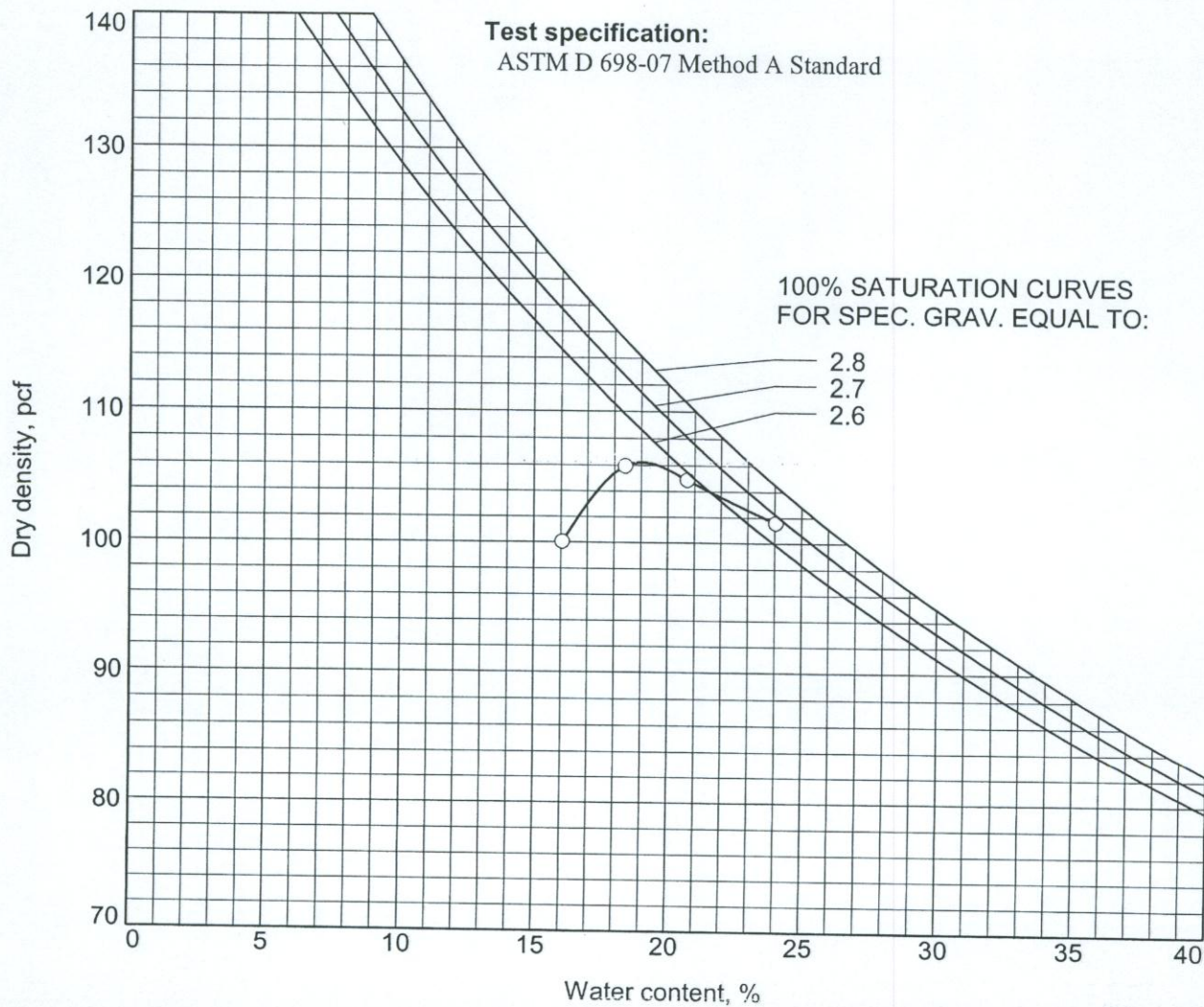
Plasticity Index = 41

% < No.200 = 83.0 %

TEST RESULTS

Maximum dry density = 106.2 pcf

Optimum moisture = 19.0 %



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Figure

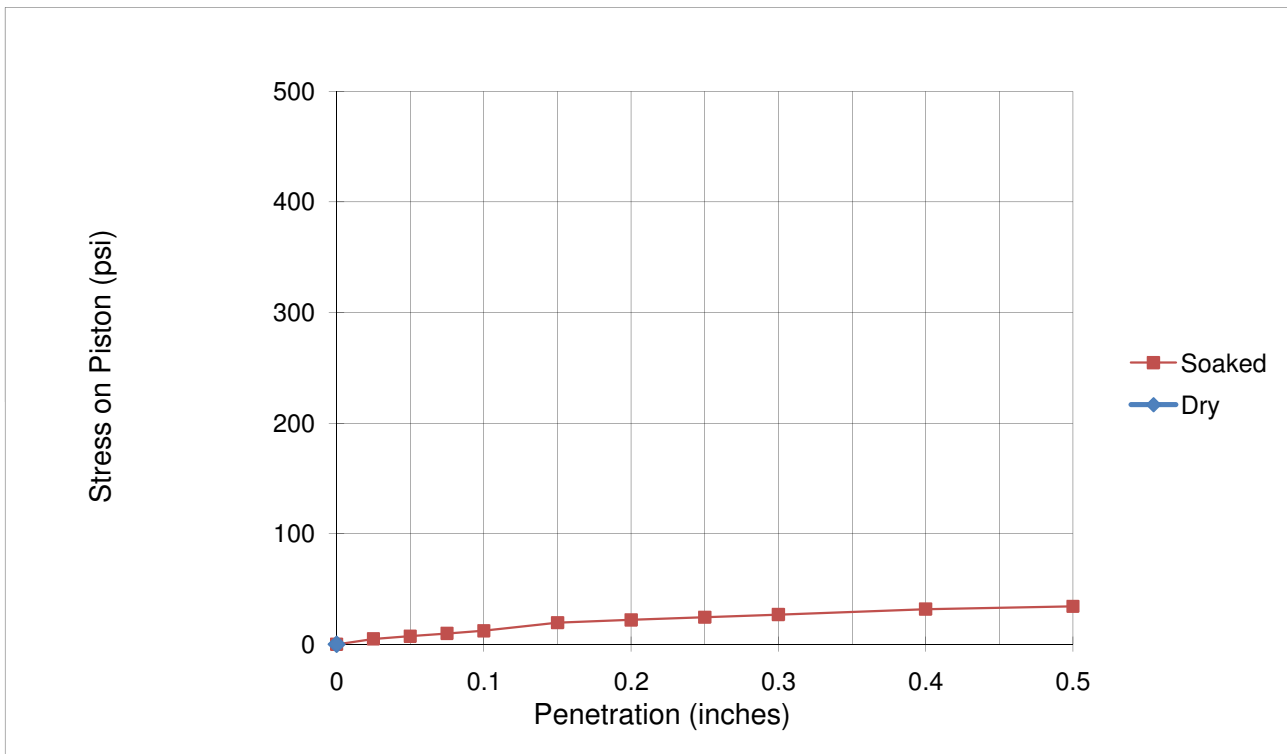
Friday, July 23, 2010


FROEHLING & ROBERTSON, INC.
 Engineering Environmental Geotechnical

 3015 Dumbarton Road
 Richmond, Virginia 23228-5831 | USA
 T 804.264.2701 | F 804.264.7862

 Project No.: 60L-5791
 Client: DJG, Inc.
 Project: AIT - Phase 1
 Location: Fort Eustis, Virginia
California Bearing Ratio
 Test Date: 1/11/2010
 Tested By: C.M.
 Compaction method: AASHTO T 193

X	Soaked CBR
X	25 BLOWS



CBR @ 0.1 in. penetration (dry):

#N/A

CBR @ 0.1 in. penetration (wet):

1.2

Swell (%):

2.8

Dry Density Before Soaking (pcf):

95.3

Dry Density After Soaking (pcf):

99.0

Retained on 3/4 inch sieve (%):

0.0

Surcharge Weight (pounds):

20.0

Moisture Content Before Soaking (%):

17.8%

Moisture Content After Soak, Top in. (%):

28.3%

Moisture Content After Soak, Ave. (%):

20.4%

Maximum Dry Density (pcf):

106.2

Optimum Moisture Content (%):

19.0

Visual Description:

Brownish Silty CLAY

F&R Lab No.: 111080

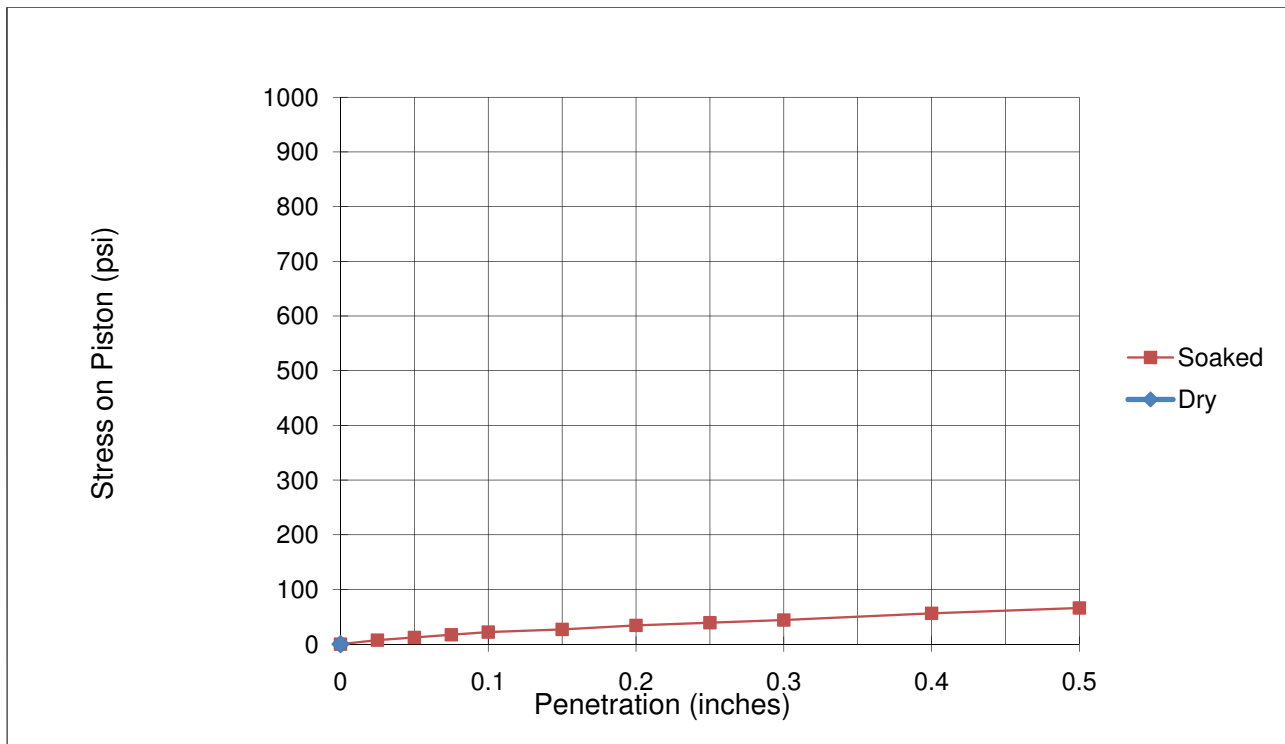
Source: P-3


FROEHLING & ROBERTSON, INC.
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 3015 Dumbarton Road
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California Bearing Ratio
 Project No.: 60L-5791
 Client: DJG, Inc.
 Project: AIT - Phase 1
 Location: Fort Eustis, Virginia

 Test Date: 1/11/2010
 Tested By: C.M.
 Compaction method: AASHTO T 193

X	Soaked CBR
X	65 BLOWS



CBR @ 0.1 in. penetration (dry):	<u>#N/A</u>
CBR @ 0.1 in. penetration (wet):	<u>2.2</u>
Swell (%):	<u>1.5</u>
Dry Density Before Soaking (pcf):	<u>104.1</u>
Dry Density After Soaking (pcf):	<u>106.5</u>
Retained on 3/4 inch sieve (%):	<u>0.0</u>

Maximum Dry Density (pcf):	<u>106.2</u>
Optimum Moisture Content (%):	<u>19.0</u>

Visual Description:
 Brownish Silty CLAY

Surcharge Weight (pounds):	<u>20.0</u>
-----------------------------------	-------------

F&R Lab No.: 111080

Moisture Content Before Soaking (%):	20.2%
Moisture Content After Soak, Top in. (%):	28.2%
Moisture Content After Soak, Ave. (%):	20.4%

Source: P-3



REQUEST FOR PROPOSAL



APPENDIX-B

LIST OF DRAWINGS

(See Appendix J for the Drawings)

DJG, Inc.

B-101 – Overall Topographic Survey

C-101 – Overall Demolition Plan

C-102 – Overall Site Plan

C-103 – Barracks and Track Site and Utility Plan

C-104 – Barracks and Track Site Grading Plan

C-105 – Dining Facility and Parking Grading Plan

C-106 – Storm Sewer Profile and Details

Center of Standardization (COS)

A101 – Barracks/Company Operations (B/COF) First Floor Plan

A102 – Barracks/Company Operations (B/COF) Second Floor Plan

A103 – Barracks/Company Operations (B/COF) Third Floor Plan

Room Module

A605 – Covered Assembly Area

A803 – Lawn Equipment Building

Attachment A – PT Pit Climbing Bars

Attachment B – Typical Track Cross Section



REQUEST FOR PROPOSAL



APPENDIX-C

UTILITY CONNECTIONS

Utility Companies Point of Contact:

Water and Sanitary Sewer

Old Dominion Utility Services (ODUS)

Julie Ball

(757) 621-1371

Email: balljm@obg.com

Electric

Dominion Virginia Power

Steve Buell

(757)434-6195

Email: steve.buell@dom.com

Gas

Virginia Natural Gas

Robert Deaver

(757) 455-5361

Email: rdeaver@aglresources.com

Communications

Network Engineering Command (NEC)

Bob Beil

(757) 878-1133

Email: bob.beil@us.army.mil

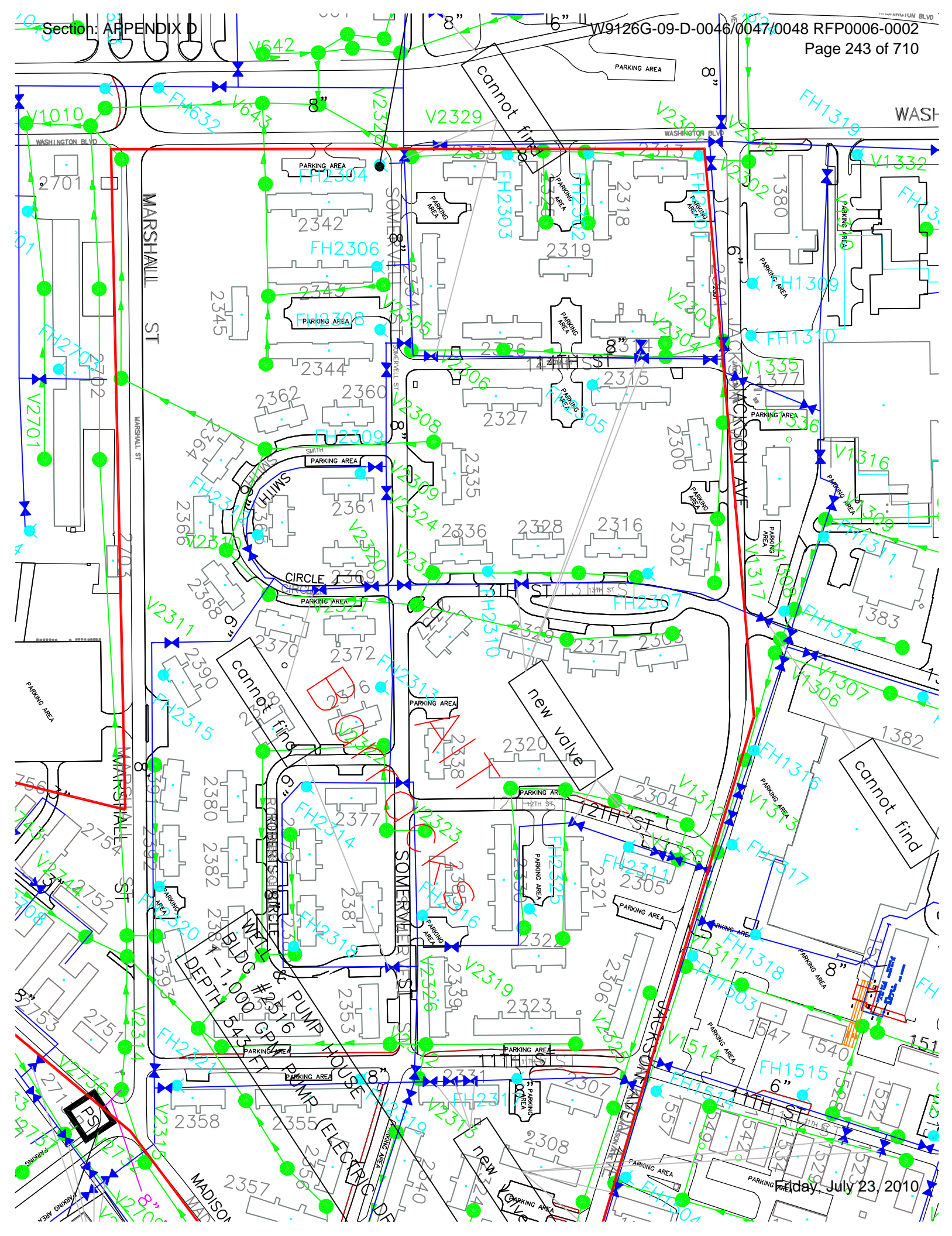


REQUEST FOR PROPOSAL



APPENDIX-D

RESULTS OF THE FIRE FLOW TESTS





Old Dominion Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09

Time 3:25

Weather Clear

Flusher / Tester

Prism CE

Temperature 90 °F / °C

Flow Hydrant

632

Diameter 2.5 inches

Coefficient 0.77

Pitot 22 psi

Flow at Residual Pressure 673 gpm

Mins/flowed 2 Water Used 180 cubic feet

Gage (test) Hydrant

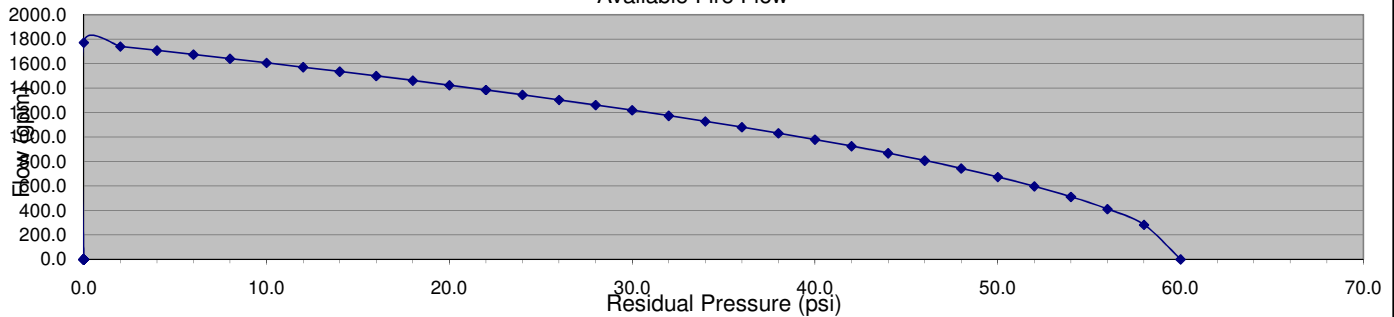
1013

Static 60 psi

Residual 50 psi

Flow available at 20psi residual 1423 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1707
2	203	29	773	56	1074	58	282	2	1740
3	249	30	786	57	1084	56	411	0	1772
4	287	31	799	58	1093	54	511	-	-
5	321	32	812	59	1103	52	597	-	-
6	352	33	825	60	1112	50	673	-	-
7	380	34	837	61	1121	48	743	-	-
8	406	35	849	62	1130	46	808	-	-
9	431	36	861	63	1139	44	868	-	-
10	454	37	873	64	1148	42	925	-	-
11	476	38	885	65	1157	40	979	-	-
12	497	39	897	66	1166	38	1031	-	-
13	518	40	908	67	1175	36	1080	-	-
14	537	41	919	68	1184	34	1128	-	-
15	556	42	930	69	1192	32	1174	-	-
16	574	43	941	70	1201	30	1219	-	-
17	592	44	952	71	1210	28	1262	-	-
18	609	45	963	72	1218	26	1304	-	-
19	626	46	974	73	1227	24	1345	-	-
20	642	47	984	74	1235	22	1385	-	-
21	658	48	995	75	1243	20	1423	-	-
22	673	49	1005	76	1251	18	1461	-	-
23	688	50	1015	77	1260	16	1499	-	-
24	703	51	1025	78	1268	14	1535	-	-
25	718	52	1035	79	1276	12	1571	-	-
26	732	53	1045	80	1284	10	1606	-	-
27	746	54	1055	81	1292	8	1640	-	-
28	760	55	1065	82	1300	6	1674	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09

Time 3:30

Weather Clear

Flusher / Tester

Prism CE

Temperature 90 °F / °C

Flow Hydrant

633

Diameter 2.5 inches

Coefficient 0.77

Pitot 22 psi

Flow at Residual Pressure 673 gpm

Mins/flowed 2 Water Used 180 cubic feet

Gage (test) Hydrant

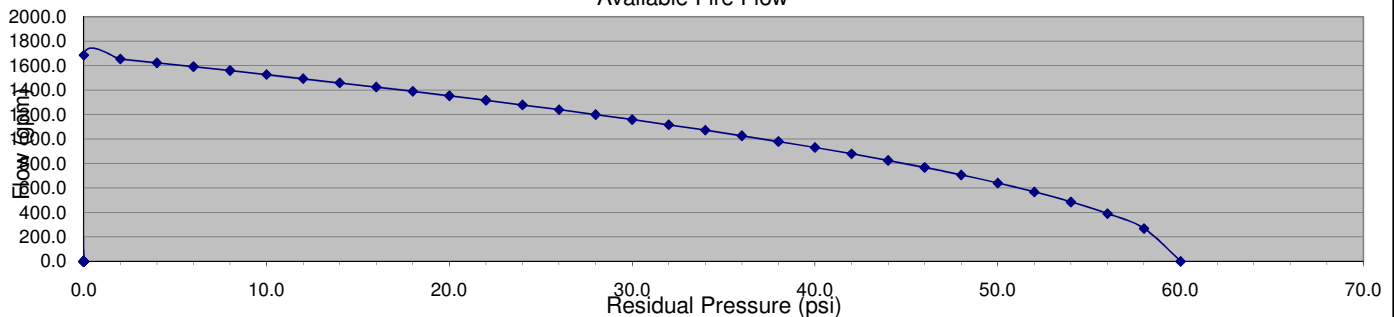
1013

Static 60 psi

Residual 49 psi

Flow available at 20psi residual 1352 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1621
2	203	29	773	56	1074	58	268	2	1652
3	249	30	786	57	1084	56	390	0	1683
4	287	31	799	58	1093	54	485	-	-
5	321	32	812	59	1103	52	567	-	-
6	352	33	825	60	1112	50	640	-	-
7	380	34	837	61	1121	48	706	-	-
8	406	35	849	62	1130	46	767	-	-
9	431	36	861	63	1139	44	824	-	-
10	454	37	873	64	1148	42	878	-	-
11	476	38	885	65	1157	40	930	-	-
12	497	39	897	66	1166	38	979	-	-
13	518	40	908	67	1175	36	1026	-	-
14	537	41	919	68	1184	34	1071	-	-
15	556	42	930	69	1192	32	1115	-	-
16	574	43	941	70	1201	30	1158	-	-
17	592	44	952	71	1210	28	1199	-	-
18	609	45	963	72	1218	26	1238	-	-
19	626	46	974	73	1227	24	1277	-	-
20	642	47	984	74	1235	22	1315	-	-
21	658	48	995	75	1243	20	1352	-	-
22	673	49	1005	76	1251	18	1388	-	-
23	688	50	1015	77	1260	16	1423	-	-
24	703	51	1025	78	1268	14	1458	-	-
25	718	52	1035	79	1276	12	1492	-	-
26	732	53	1045	80	1284	10	1525	-	-
27	746	54	1055	81	1292	8	1558	-	-
28	760	55	1065	82	1300	6	1590	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/21/09

Time 11:55

Weather Clear

Flusher / Tester

Prism CE

Temperature 75 °F / °C

Flow Hydrant

1309

Diameter 2.5 inches

Coefficient 0.77

Pitot 10 psi

Flow at Residual Pressure 454 gpm

Mins/flowed 2 Water Used 121 cubic feet

Gage (test) Hydrant

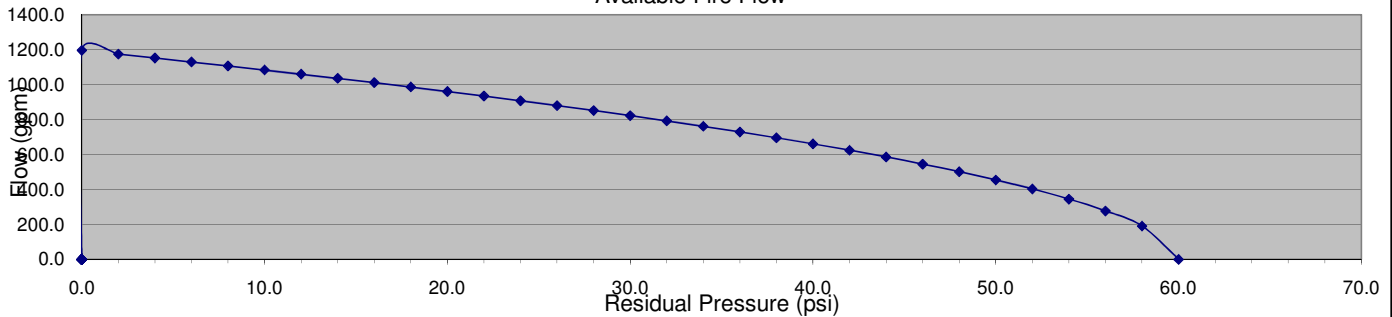
2301

Static 60 psi

Residual 50 psi

Flow available at 20psi residual 960 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1151
2	203	29	773	56	1074	58	190	2	1173
3	249	30	786	57	1084	56	277	0	1195
4	287	31	799	58	1093	54	345	-	-
5	321	32	812	59	1103	52	402	-	-
6	352	33	825	60	1112	50	454	-	-
7	380	34	837	61	1121	48	501	-	-
8	406	35	849	62	1130	46	544	-	-
9	431	36	861	63	1139	44	585	-	-
10	454	37	873	64	1148	42	624	-	-
11	476	38	885	65	1157	40	660	-	-
12	497	39	897	66	1166	38	695	-	-
13	518	40	908	67	1175	36	728	-	-
14	537	41	919	68	1184	34	761	-	-
15	556	42	930	69	1192	32	792	-	-
16	574	43	941	70	1201	30	822	-	-
17	592	44	952	71	1210	28	851	-	-
18	609	45	963	72	1218	26	879	-	-
19	626	46	974	73	1227	24	907	-	-
20	642	47	984	74	1235	22	933	-	-
21	658	48	995	75	1243	20	960	-	-
22	673	49	1005	76	1251	18	985	-	-
23	688	50	1015	77	1260	16	1010	-	-
24	703	51	1025	78	1268	14	1035	-	-
25	718	52	1035	79	1276	12	1059	-	-
26	732	53	1045	80	1284	10	1083	-	-
27	746	54	1055	81	1292	8	1106	-	-
28	760	55	1065	82	1300	6	1129	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/21/09

Time 11:05

Weather Clear

Flusher / Tester

Prism CE

Temperature 70 °F / °C

Flow Hydrant

1310

Diameter 2.5 inches

Coefficient 0.77

Pitot 22 psi

Flow at Residual Pressure 673 gpm

Mins/flowed 2 Water Used 180 cubic feet

Gage (test) Hydrant

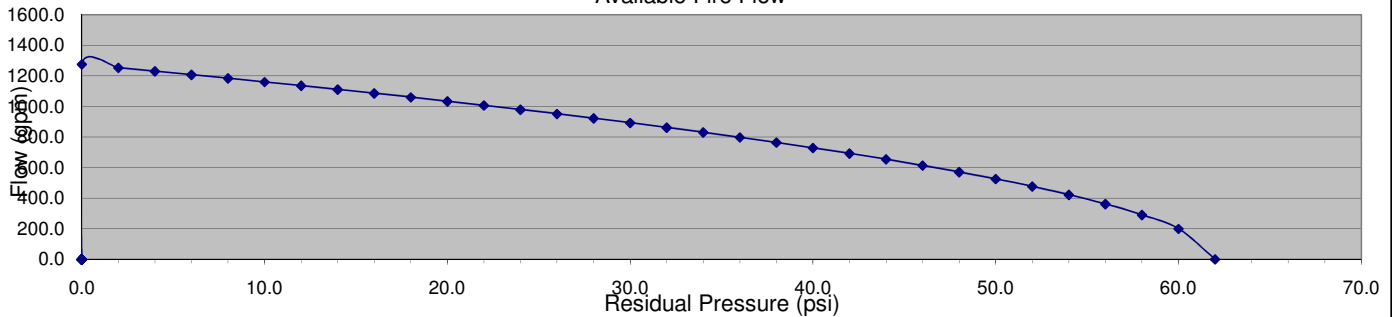
1309

Static 62 psi

Residual 43 psi

Flow available at 20psi residual 1033 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	62	0	6	1207
2	203	29	773	56	1074	60	200	4	1230
3	249	30	786	57	1084	58	290	2	1253
4	287	31	799	58	1093	56	361	0	1275
5	321	32	812	59	1103	54	422	-	-
6	352	33	825	60	1112	52	476	-	-
7	380	34	837	61	1121	50	525	-	-
8	406	35	849	62	1130	48	571	-	-
9	431	36	861	63	1139	46	614	-	-
10	454	37	873	64	1148	44	654	-	-
11	476	38	885	65	1157	42	692	-	-
12	497	39	897	66	1166	40	729	-	-
13	518	40	908	67	1175	38	764	-	-
14	537	41	919	68	1184	36	798	-	-
15	556	42	930	69	1192	34	830	-	-
16	574	43	941	70	1201	32	862	-	-
17	592	44	952	71	1210	30	892	-	-
18	609	45	963	72	1218	28	922	-	-
19	626	46	974	73	1227	26	951	-	-
20	642	47	984	74	1235	24	979	-	-
21	658	48	995	75	1243	22	1007	-	-
22	673	49	1005	76	1251	20	1033	-	-
23	688	50	1015	77	1260	18	1060	-	-
24	703	51	1025	78	1268	16	1085	-	-
25	718	52	1035	79	1276	14	1111	-	-
26	732	53	1045	80	1284	12	1135	-	-
27	746	54	1055	81	1292	10	1160	-	-
28	760	55	1065	82	1300	8	1184	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09Time 10:25Weather Clear

Flusher / Tester

Prism CETemperature 80 °F / °C

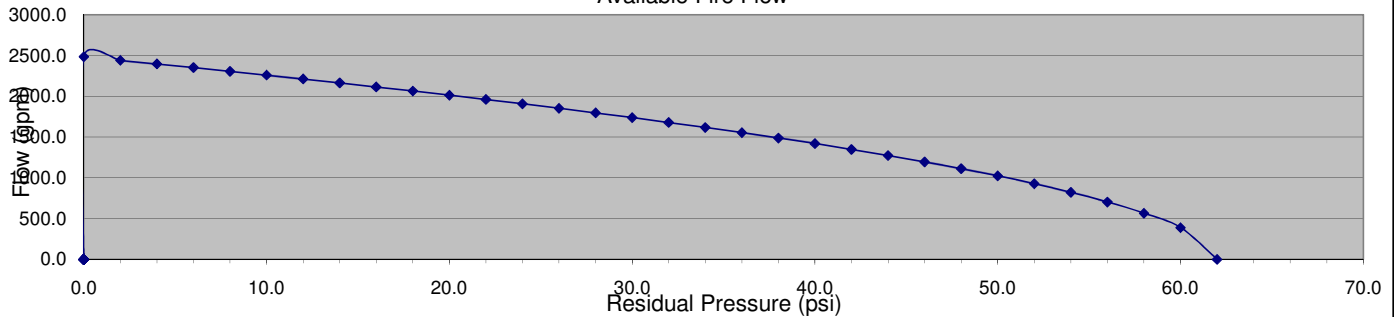
Flow Hydrant

1311Diameter 2.5 inchesCoefficient 0.77Pitot 24 psiFlow at Residual Pressure 703 gpmMins/flowed 2 Water Used 188 cubic feet

Gage (test) Hydrant

2310Static 62 psiResidual 56 psiFlow available at 20psi residual 2011 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	62	0	6	2349
2	203	29	773	56	1074	60	389	4	2394
3	249	30	786	57	1084	58	565	2	2439
4	287	31	799	58	1093	56	703	0	2482
5	321	32	812	59	1103	54	821	-	-
6	352	33	825	60	1112	52	927	-	-
7	380	34	837	61	1121	50	1023	-	-
8	406	35	849	62	1130	48	1111	-	-
9	431	36	861	63	1139	46	1194	-	-
10	454	37	873	64	1148	44	1273	-	-
11	476	38	885	65	1157	42	1347	-	-
12	497	39	897	66	1166	40	1419	-	-
13	518	40	908	67	1175	38	1487	-	-
14	537	41	919	68	1184	36	1552	-	-
15	556	42	930	69	1192	34	1616	-	-
16	574	43	941	70	1201	32	1677	-	-
17	592	44	952	71	1210	30	1737	-	-
18	609	45	963	72	1218	28	1794	-	-
19	626	46	974	73	1227	26	1851	-	-
20	642	47	984	74	1235	24	1906	-	-
21	658	48	995	75	1243	22	1959	-	-
22	673	49	1005	76	1251	20	2011	-	-
23	688	50	1015	77	1260	18	2062	-	-
24	703	51	1025	78	1268	16	2113	-	-
25	718	52	1035	79	1276	14	2162	-	-
26	732	53	1045	80	1284	12	2210	-	-
27	746	54	1055	81	1292	10	2257	-	-
28	760	55	1065	82	1300	8	2304	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09

Time 11:45

Weather Clear

Flusher / Tester

Prism CE

Temperature 80 °F / °C

Flow Hydrant

1316

Diameter 2.5 inches

Coefficient 0.77

Pitot 20 psi

Flow at Residual Pressure 642 gpm

Mins/flowed 2 Water Used 172 cubic feet

Gage (test) Hydrant

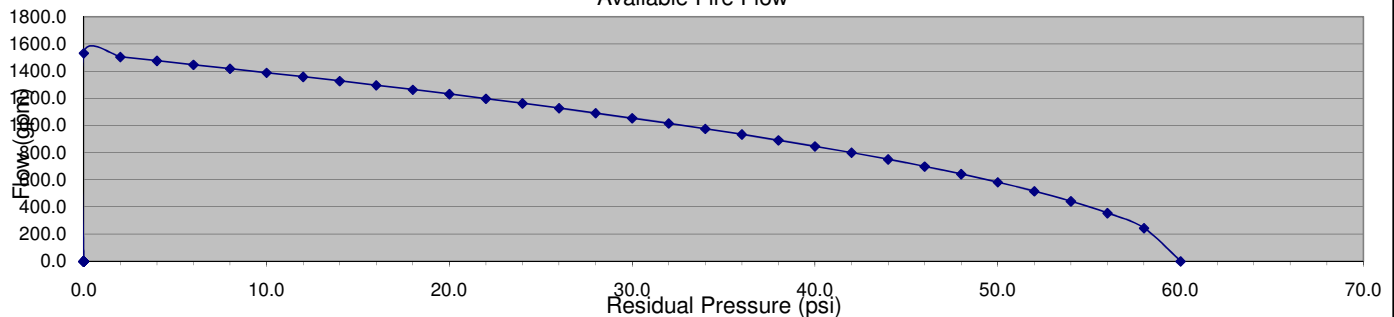
1318

Static 60 psi

Residual 48 psi

Flow available at 20psi residual 1230 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1475
2	203	29	773	56	1074	58	244	2	1503
3	249	30	786	57	1084	56	355	0	1531
4	287	31	799	58	1093	54	442	-	-
5	321	32	812	59	1103	52	516	-	-
6	352	33	825	60	1112	50	582	-	-
7	380	34	837	61	1121	48	642	-	-
8	406	35	849	62	1130	46	698	-	-
9	431	36	861	63	1139	44	750	-	-
10	454	37	873	64	1148	42	799	-	-
11	476	38	885	65	1157	40	846	-	-
12	497	39	897	66	1166	38	891	-	-
13	518	40	908	67	1175	36	933	-	-
14	537	41	919	68	1184	34	975	-	-
15	556	42	930	69	1192	32	1014	-	-
16	574	43	941	70	1201	30	1053	-	-
17	592	44	952	71	1210	28	1090	-	-
18	609	45	963	72	1218	26	1127	-	-
19	626	46	974	73	1227	24	1162	-	-
20	642	47	984	74	1235	22	1196	-	-
21	658	48	995	75	1243	20	1230	-	-
22	673	49	1005	76	1251	18	1263	-	-
23	688	50	1015	77	1260	16	1295	-	-
24	703	51	1025	78	1268	14	1326	-	-
25	718	52	1035	79	1276	12	1357	-	-
26	732	53	1045	80	1284	10	1387	-	-
27	746	54	1055	81	1292	8	1417	-	-
28	760	55	1065	82	1300	6	1446	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09

Time 11:50

Weather Clear

Flusher / Tester

Prism CE

Temperature 80 °F / °C

Flow Hydrant

1317

Diameter 2.5 inches

Coefficient 0.77

Pitot 20 psi

Flow at Residual Pressure 642 gpm

Mins/flowed 2 Water Used 172 cubic feet

Gage (test) Hydrant

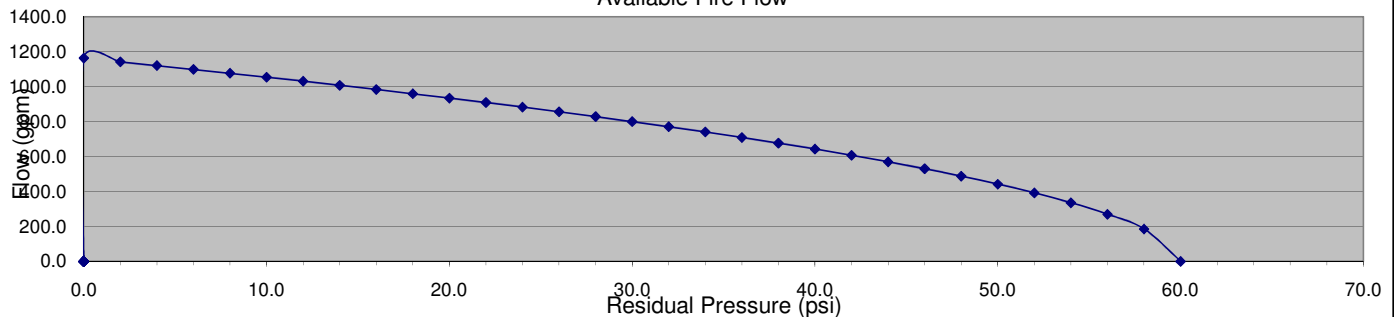
1318

Static 60 psi

Residual 40 psi

Flow available at 20psi residual 933 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1119
2	203	29	773	56	1074	58	185	2	1141
3	249	30	786	57	1084	56	269	0	1162
4	287	31	799	58	1093	54	335	-	-
5	321	32	812	59	1103	52	391	-	-
6	352	33	825	60	1112	50	442	-	-
7	380	34	837	61	1121	48	487	-	-
8	406	35	849	62	1130	46	530	-	-
9	431	36	861	63	1139	44	569	-	-
10	454	37	873	64	1148	42	606	-	-
11	476	38	885	65	1157	40	642	-	-
12	497	39	897	66	1166	38	676	-	-
13	518	40	908	67	1175	36	708	-	-
14	537	41	919	68	1184	34	740	-	-
15	556	42	930	69	1192	32	770	-	-
16	574	43	941	70	1201	30	799	-	-
17	592	44	952	71	1210	28	827	-	-
18	609	45	963	72	1218	26	855	-	-
19	626	46	974	73	1227	24	882	-	-
20	642	47	984	74	1235	22	908	-	-
21	658	48	995	75	1243	20	933	-	-
22	673	49	1005	76	1251	18	958	-	-
23	688	50	1015	77	1260	16	983	-	-
24	703	51	1025	78	1268	14	1007	-	-
25	718	52	1035	79	1276	12	1030	-	-
26	732	53	1045	80	1284	10	1053	-	-
27	746	54	1055	81	1292	8	1076	-	-
28	760	55	1065	82	1300	6	1098	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09Time 11:55Weather Clear

Flusher / Tester

Prism CETemperature 80 °F / °C

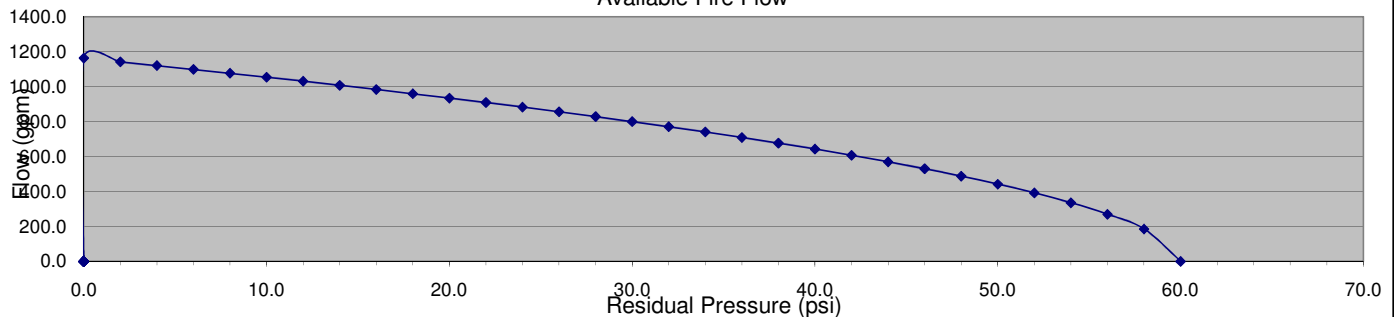
Flow Hydrant

1318Diameter 2.5 inchesCoefficient 0.77Pitot 20 psiFlow at Residual Pressure 642 gpmMins/flowed 2 Water Used 172 cubic feet

Gage (test) Hydrant

1503Static 60 psiResidual 40 psiFlow available at 20psi residual 933 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1119
2	203	29	773	56	1074	58	185	2	1141
3	249	30	786	57	1084	56	269	0	1162
4	287	31	799	58	1093	54	335	-	-
5	321	32	812	59	1103	52	391	-	-
6	352	33	825	60	1112	50	442	-	-
7	380	34	837	61	1121	48	487	-	-
8	406	35	849	62	1130	46	530	-	-
9	431	36	861	63	1139	44	569	-	-
10	454	37	873	64	1148	42	606	-	-
11	476	38	885	65	1157	40	642	-	-
12	497	39	897	66	1166	38	676	-	-
13	518	40	908	67	1175	36	708	-	-
14	537	41	919	68	1184	34	740	-	-
15	556	42	930	69	1192	32	770	-	-
16	574	43	941	70	1201	30	799	-	-
17	592	44	952	71	1210	28	827	-	-
18	609	45	963	72	1218	26	855	-	-
19	626	46	974	73	1227	24	882	-	-
20	642	47	984	74	1235	22	908	-	-
21	658	48	995	75	1243	20	933	-	-
22	673	49	1005	76	1251	18	958	-	-
23	688	50	1015	77	1260	16	983	-	-
24	703	51	1025	78	1268	14	1007	-	-
25	718	52	1035	79	1276	12	1030	-	-
26	732	53	1045	80	1284	10	1053	-	-
27	746	54	1055	81	1292	8	1076	-	-
28	760	55	1065	82	1300	6	1098	-	-



Old Dominion Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 06/24/09

Time 3:20

Weather Sunny

Flusher / Tester

Prism CE

Temperature 85 °F / °C

Flow Hydrant

1319

Diameter 2.5 inches

Coefficient 0.77

Pitot 25 psi

Flow at Residual Pressure 718 gpm

Mins/flowed 2 Water Used 192 cubic feet

Gage (test) Hydrant

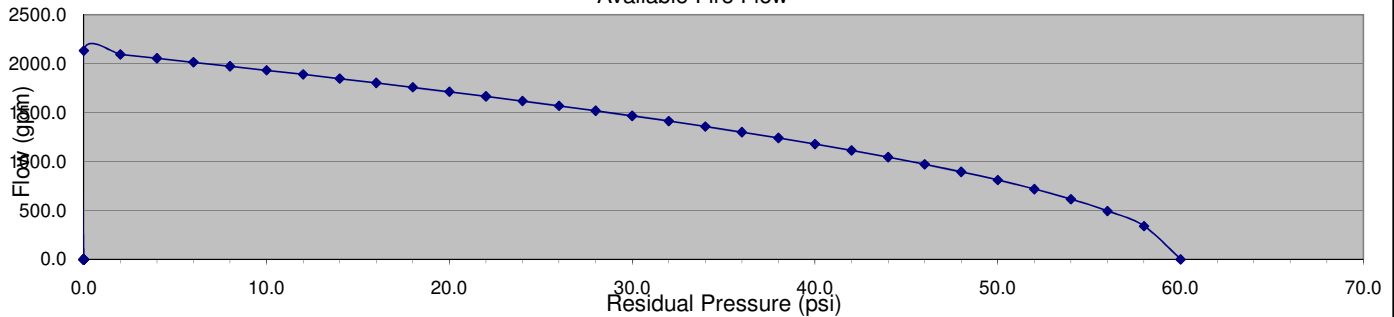
1322

Static 60 psi

Residual 52 psi

Flow available at 20psi residual 1712 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	2053
2	203	29	773	56	1074	58	340	2	2092
3	249	30	786	57	1084	56	494	0	2131
4	287	31	799	58	1093	54	615	-	-
5	321	32	812	59	1103	52	718	-	-
6	352	33	825	60	1112	50	810	-	-
7	380	34	837	61	1121	48	893	-	-
8	406	35	849	62	1130	46	971	-	-
9	431	36	861	63	1139	44	1044	-	-
10	454	37	873	64	1148	42	1112	-	-
11	476	38	885	65	1157	40	1177	-	-
12	497	39	897	66	1166	38	1239	-	-
13	518	40	908	67	1175	36	1299	-	-
14	537	41	919	68	1184	34	1356	-	-
15	556	42	930	69	1192	32	1412	-	-
16	574	43	941	70	1201	30	1465	-	-
17	592	44	952	71	1210	28	1517	-	-
18	609	45	963	72	1218	26	1568	-	-
19	626	46	974	73	1227	24	1617	-	-
20	642	47	984	74	1235	22	1665	-	-
21	658	48	995	75	1243	20	1712	-	-
22	673	49	1005	76	1251	18	1757	-	-
23	688	50	1015	77	1260	16	1802	-	-
24	703	51	1025	78	1268	14	1846	-	-
25	718	52	1035	79	1276	12	1889	-	-
26	732	53	1045	80	1284	10	1931	-	-
27	746	54	1055	81	1292	8	1972	-	-
28	760	55	1065	82	1300	6	2013	-	-



Old Dominion

Utility Services, Inc.

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FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09

Time 11:40

Weather Clear

Flusher / Tester

Prism CE

Temperature 80 °F / °C

Flow Hydrant

1503

Diameter 2.5 inches

Coefficient 0.77

Pitot 20 psi

Flow at Residual Pressure 642 gpm

Mins/flowed 2 Water Used 172 cubic feet

Gage (test) Hydrant

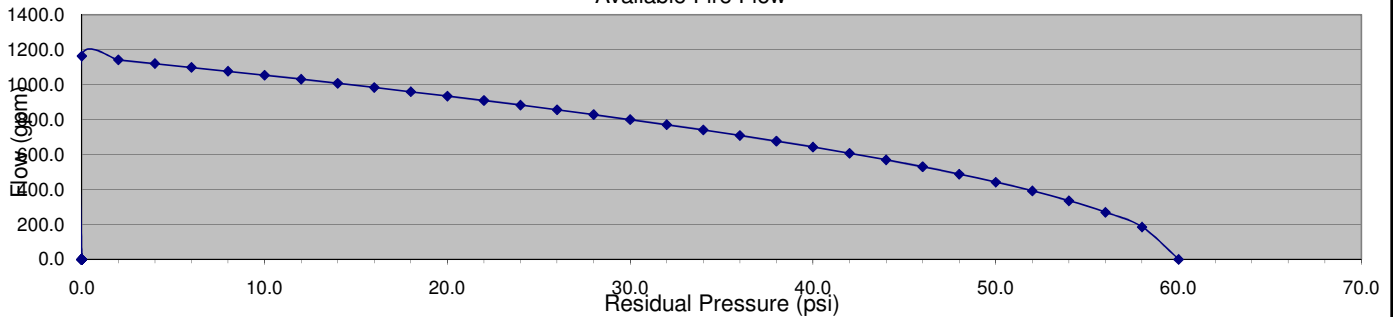
1318

Static 60 psi

Residual 40 psi

Flow available at 20psi residual 933 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1119
2	203	29	773	56	1074	58	185	2	1141
3	249	30	786	57	1084	56	269	0	1162
4	287	31	799	58	1093	54	335	-	-
5	321	32	812	59	1103	52	391	-	-
6	352	33	825	60	1112	50	442	-	-
7	380	34	837	61	1121	48	487	-	-
8	406	35	849	62	1130	46	530	-	-
9	431	36	861	63	1139	44	569	-	-
10	454	37	873	64	1148	42	606	-	-
11	476	38	885	65	1157	40	642	-	-
12	497	39	897	66	1166	38	676	-	-
13	518	40	908	67	1175	36	708	-	-
14	537	41	919	68	1184	34	740	-	-
15	556	42	930	69	1192	32	770	-	-
16	574	43	941	70	1201	30	799	-	-
17	592	44	952	71	1210	28	827	-	-
18	609	45	963	72	1218	26	855	-	-
19	626	46	974	73	1227	24	882	-	-
20	642	47	984	74	1235	22	908	-	-
21	658	48	995	75	1243	20	933	-	-
22	673	49	1005	76	1251	18	958	-	-
23	688	50	1015	77	1260	16	983	-	-
24	703	51	1025	78	1268	14	1007	-	-
25	718	52	1035	79	1276	12	1030	-	-
26	732	53	1045	80	1284	10	1053	-	-
27	746	54	1055	81	1292	8	1076	-	-
28	760	55	1065	82	1300	6	1098	-	-



Old Dominion

Utility Services, Inc.

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FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09

Time 12:20

Weather Clear

Flusher / Tester

Prism CE

Temperature 85 °F / °C

Flow Hydrant

1504

Diameter 2.5 inches

Coefficient 0.77

Pitot 20 psi

Flow at Residual Pressure 642 gpm

Mins/flowed 2 Water Used 172 cubic feet

Gage (test) Hydrant

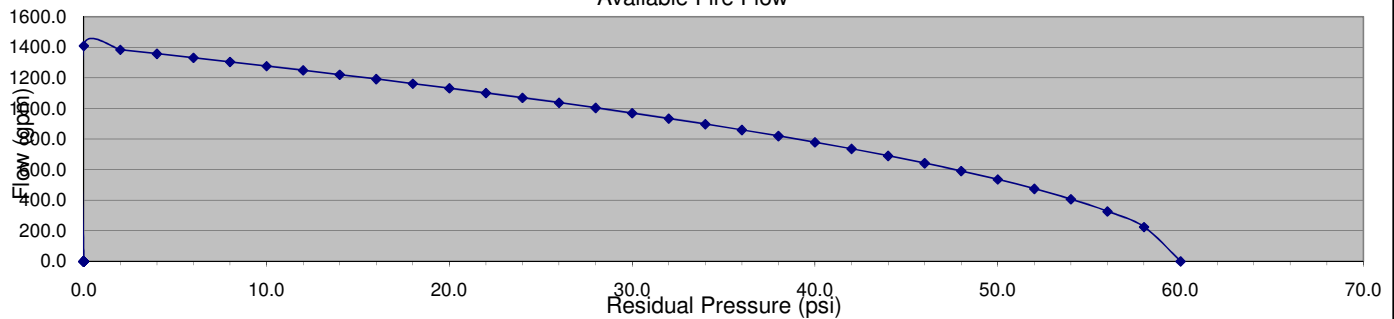
1514

Static 60 psi

Residual 46 psi

Flow available at 20psi residual 1132 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1357
2	203	29	773	56	1074	58	224	2	1383
3	249	30	786	57	1084	56	326	0	1409
4	287	31	799	58	1093	54	406	-	-
5	321	32	812	59	1103	52	475	-	-
6	352	33	825	60	1112	50	535	-	-
7	380	34	837	61	1121	48	591	-	-
8	406	35	849	62	1130	46	642	-	-
9	431	36	861	63	1139	44	690	-	-
10	454	37	873	64	1148	42	735	-	-
11	476	38	885	65	1157	40	778	-	-
12	497	39	897	66	1166	38	819	-	-
13	518	40	908	67	1175	36	859	-	-
14	537	41	919	68	1184	34	897	-	-
15	556	42	930	69	1192	32	933	-	-
16	574	43	941	70	1201	30	969	-	-
17	592	44	952	71	1210	28	1003	-	-
18	609	45	963	72	1218	26	1037	-	-
19	626	46	974	73	1227	24	1069	-	-
20	642	47	984	74	1235	22	1101	-	-
21	658	48	995	75	1243	20	1132	-	-
22	673	49	1005	76	1251	18	1162	-	-
23	688	50	1015	77	1260	16	1192	-	-
24	703	51	1025	78	1268	14	1220	-	-
25	718	52	1035	79	1276	12	1249	-	-
26	732	53	1045	80	1284	10	1277	-	-
27	746	54	1055	81	1292	8	1304	-	-
28	760	55	1065	82	1300	6	1331	-	-



Old Dominion

Utility Services, Inc.

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FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09

Time 12:25

Weather Clear

Flusher / Tester

Prism CE

Temperature 85 °F / °C

Flow Hydrant

1509

Diameter 2.5 inches

Coefficient 0.77

Pitot 19 psi

Flow at Residual Pressure 626 gpm

Mins/flowed 2 Water Used 167 cubic feet

Gage (test) Hydrant

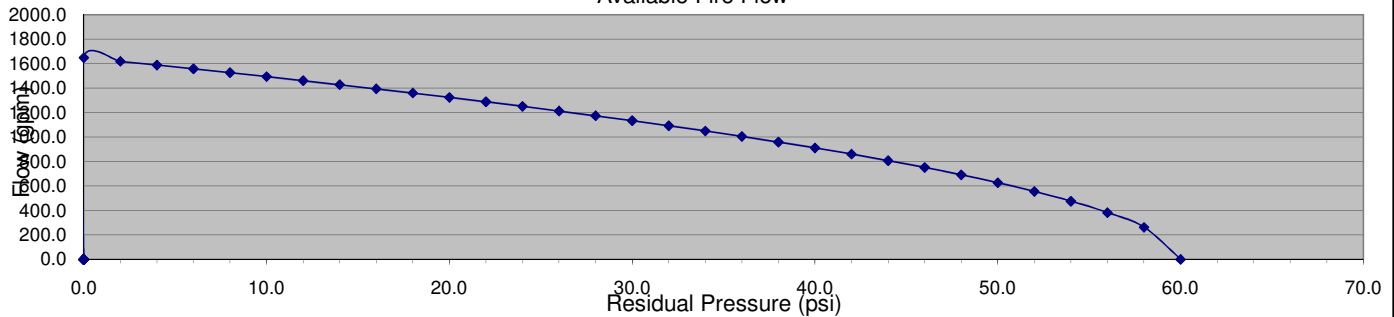
1514

Static 60 psi

Residual 50 psi

Flow available at 20psi residual 1323 gpm

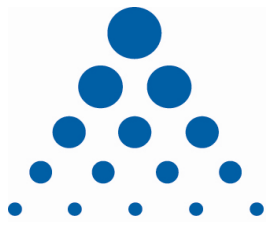
Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1586
2	203	29	773	56	1074	58	262	2	1617
3	249	30	786	57	1084	56	382	0	1647
4	287	31	799	58	1093	54	475	-	-
5	321	32	812	59	1103	52	555	-	-
6	352	33	825	60	1112	50	626	-	-
7	380	34	837	61	1121	48	690	-	-
8	406	35	849	62	1130	46	750	-	-
9	431	36	861	63	1139	44	807	-	-
10	454	37	873	64	1148	42	860	-	-
11	476	38	885	65	1157	40	910	-	-
12	497	39	897	66	1166	38	958	-	-
13	518	40	908	67	1175	36	1004	-	-
14	537	41	919	68	1184	34	1048	-	-
15	556	42	930	69	1192	32	1091	-	-
16	574	43	941	70	1201	30	1133	-	-
17	592	44	952	71	1210	28	1173	-	-
18	609	45	963	72	1218	26	1212	-	-
19	626	46	974	73	1227	24	1250	-	-
20	642	47	984	74	1235	22	1287	-	-
21	658	48	995	75	1243	20	1323	-	-
22	673	49	1005	76	1251	18	1358	-	-
23	688	50	1015	77	1260	16	1393	-	-
24	703	51	1025	78	1268	14	1427	-	-
25	718	52	1035	79	1276	12	1460	-	-
26	732	53	1045	80	1284	10	1492	-	-
27	746	54	1055	81	1292	8	1524	-	-
28	760	55	1065	82	1300	6	1556	-	-



Old Dominion

Utility Services, Inc.

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FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09Time 12:45Weather Clear

Flusher / Tester

Prism CETemperature 90 °F / °C

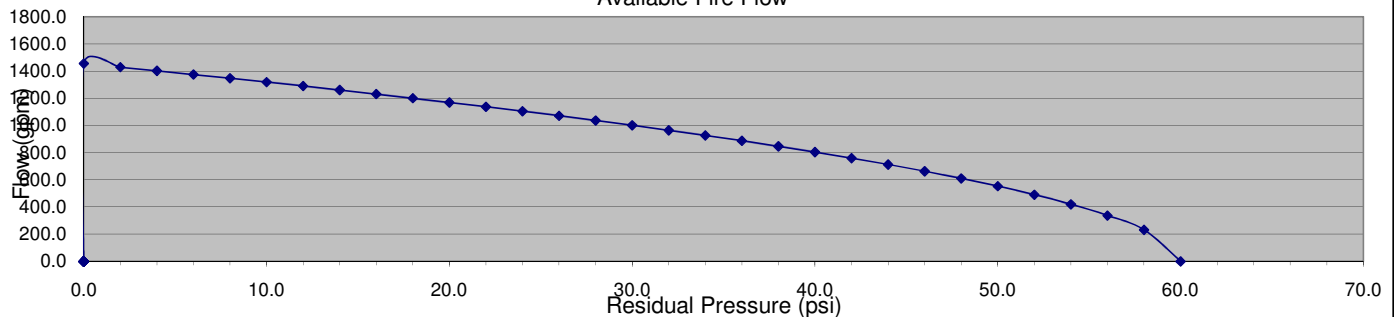
Flow Hydrant

1510Diameter 2.5 inchesCoefficient 0.77Pitot 23 psiFlow at Residual Pressure 688 gpmMins/flowed 2 Water Used 184 cubic feet

Gage (test) Hydrant

1509Static 60 psiResidual 45 psiFlow available at 20psi residual 1169 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1402
2	203	29	773	56	1074	58	232	2	1429
3	249	30	786	57	1084	56	337	0	1455
4	287	31	799	58	1093	54	420	-	-
5	321	32	812	59	1103	52	490	-	-
6	352	33	825	60	1112	50	553	-	-
7	380	34	837	61	1121	48	610	-	-
8	406	35	849	62	1130	46	663	-	-
9	431	36	861	63	1139	44	713	-	-
10	454	37	873	64	1148	42	760	-	-
11	476	38	885	65	1157	40	804	-	-
12	497	39	897	66	1166	38	847	-	-
13	518	40	908	67	1175	36	887	-	-
14	537	41	919	68	1184	34	927	-	-
15	556	42	930	69	1192	32	964	-	-
16	574	43	941	70	1201	30	1001	-	-
17	592	44	952	71	1210	28	1037	-	-
18	609	45	963	72	1218	26	1071	-	-
19	626	46	974	73	1227	24	1105	-	-
20	642	47	984	74	1235	22	1137	-	-
21	658	48	995	75	1243	20	1169	-	-
22	673	49	1005	76	1251	18	1200	-	-
23	688	50	1015	77	1260	16	1231	-	-
24	703	51	1025	78	1268	14	1261	-	-
25	718	52	1035	79	1276	12	1290	-	-
26	732	53	1045	80	1284	10	1319	-	-
27	746	54	1055	81	1292	8	1347	-	-
28	760	55	1065	82	1300	6	1375	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09

Time 12:30

Weather Clear

Flusher / Tester

Prism CE

Temperature 85 °F / °C

Flow Hydrant

1514

Diameter 2.5 inches

Coefficient 0.77

Pitot 20 psi

Flow at Residual Pressure 642 gpm

Mins/flowed 2 Water Used 172 cubic feet

Gage (test) Hydrant

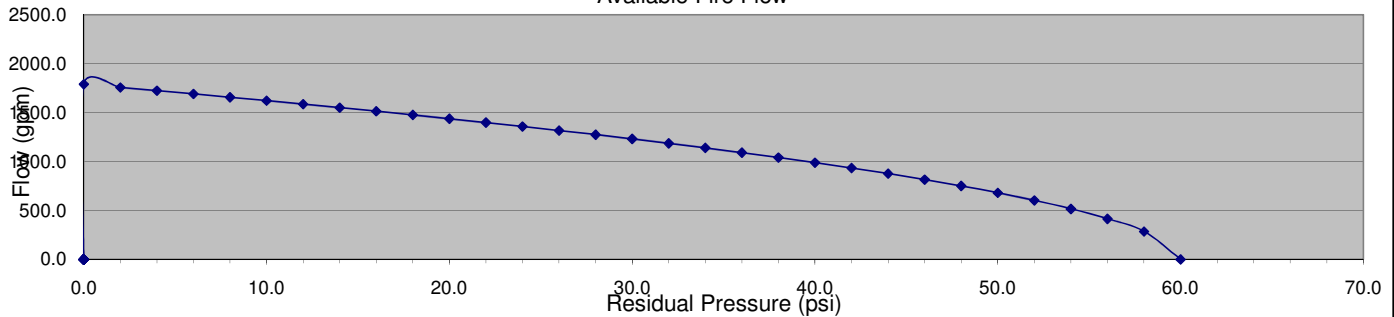
1509

Static 60 psi

Residual 51 psi

Flow available at 20psi residual 1437 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1723
2	203	29	773	56	1074	58	285	2	1756
3	249	30	786	57	1084	56	414	0	1788
4	287	31	799	58	1093	54	516	-	-
5	321	32	812	59	1103	52	602	-	-
6	352	33	825	60	1112	50	680	-	-
7	380	34	837	61	1121	48	750	-	-
8	406	35	849	62	1130	46	815	-	-
9	431	36	861	63	1139	44	876	-	-
10	454	37	873	64	1148	42	933	-	-
11	476	38	885	65	1157	40	988	-	-
12	497	39	897	66	1166	38	1040	-	-
13	518	40	908	67	1175	36	1090	-	-
14	537	41	919	68	1184	34	1139	-	-
15	556	42	930	69	1192	32	1185	-	-
16	574	43	941	70	1201	30	1230	-	-
17	592	44	952	71	1210	28	1274	-	-
18	609	45	963	72	1218	26	1316	-	-
19	626	46	974	73	1227	24	1357	-	-
20	642	47	984	74	1235	22	1397	-	-
21	658	48	995	75	1243	20	1437	-	-
22	673	49	1005	76	1251	18	1475	-	-
23	688	50	1015	77	1260	16	1513	-	-
24	703	51	1025	78	1268	14	1549	-	-
25	718	52	1035	79	1276	12	1585	-	-
26	732	53	1045	80	1284	10	1621	-	-
27	746	54	1055	81	1292	8	1655	-	-
28	760	55	1065	82	1300	6	1689	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/29/09

Time 9:50

Weather Clear

Flusher / Tester

Prism CE

Temperature 70 °F / °C

Flow Hydrant

1715

Diameter 2.5 inches

Coefficient 0.77

Pitot 26 psi

Flow at Residual Pressure 732 gpm

Mins/flowed 2 Water Used 196 cubic feet

Gage (test) Hydrant

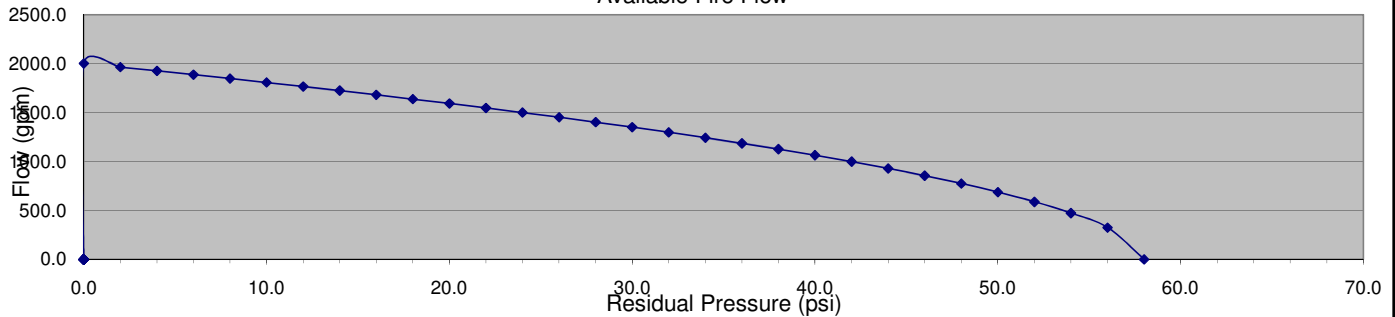
1512

Static 58 psi

Residual 49 psi

Flow available at 20psi residual 1593 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	58	0	2	1964
2	203	29	773	56	1074	56	325	0	2002
3	249	30	786	57	1084	54	472	-	-
4	287	31	799	58	1093	52	588	-	-
5	321	32	812	59	1103	50	687	-	-
6	352	33	825	60	1112	48	775	-	-
7	380	34	837	61	1121	46	855	-	-
8	406	35	849	62	1130	44	929	-	-
9	431	36	861	63	1139	42	999	-	-
10	454	37	873	64	1148	40	1064	-	-
11	476	38	885	65	1157	38	1127	-	-
12	497	39	897	66	1166	36	1186	-	-
13	518	40	908	67	1175	34	1243	-	-
14	537	41	919	68	1184	32	1298	-	-
15	556	42	930	69	1192	30	1351	-	-
16	574	43	941	70	1201	28	1402	-	-
17	592	44	952	71	1210	26	1452	-	-
18	609	45	963	72	1218	24	1500	-	-
19	626	46	974	73	1227	22	1547	-	-
20	642	47	984	74	1235	20	1593	-	-
21	658	48	995	75	1243	18	1638	-	-
22	673	49	1005	76	1251	16	1682	-	-
23	688	50	1015	77	1260	14	1725	-	-
24	703	51	1025	78	1268	12	1766	-	-
25	718	52	1035	79	1276	10	1808	-	-
26	732	53	1045	80	1284	8	1848	-	-
27	746	54	1055	81	1292	6	1887	-	-
28	760	55	1065	82	1300	4	1926	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/21/09

Time 11:15

Weather Clear

Flusher / Tester

Prism CE

Temperature 75 °F / °C

Flow Hydrant

2301

Diameter 2.5 inches

Coefficient 0.77

Pitot 20 psi

Flow at Residual Pressure 642 gpm

Mins/flowed 2 Water Used 172 cubic feet

Gage (test) Hydrant

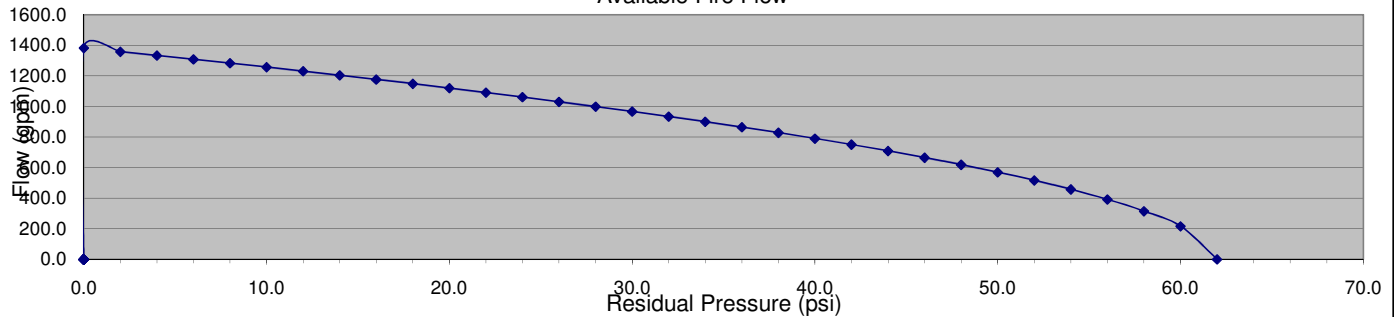
1309

Static 62 psi

Residual 47 psi

Flow available at 20psi residual 1119 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	62	0	6	1308
2	203	29	773	56	1074	60	216	4	1333
3	249	30	786	57	1084	58	314	2	1357
4	287	31	799	58	1093	56	391	0	1381
5	321	32	812	59	1103	54	457	-	-
6	352	33	825	60	1112	52	516	-	-
7	380	34	837	61	1121	50	569	-	-
8	406	35	849	62	1130	48	619	-	-
9	431	36	861	63	1139	46	665	-	-
10	454	37	873	64	1148	44	708	-	-
11	476	38	885	65	1157	42	750	-	-
12	497	39	897	66	1166	40	790	-	-
13	518	40	908	67	1175	38	827	-	-
14	537	41	919	68	1184	36	864	-	-
15	556	42	930	69	1192	34	899	-	-
16	574	43	941	70	1201	32	933	-	-
17	592	44	952	71	1210	30	967	-	-
18	609	45	963	72	1218	28	999	-	-
19	626	46	974	73	1227	26	1030	-	-
20	642	47	984	74	1235	24	1061	-	-
21	658	48	995	75	1243	22	1090	-	-
22	673	49	1005	76	1251	20	1119	-	-
23	688	50	1015	77	1260	18	1148	-	-
24	703	51	1025	78	1268	16	1176	-	-
25	718	52	1035	79	1276	14	1203	-	-
26	732	53	1045	80	1284	12	1230	-	-
27	746	54	1055	81	1292	10	1256	-	-
28	760	55	1065	82	1300	8	1282	-	-



Old Dominion Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/21/09Time 11:30Weather Clear

Flusher / Tester

Prism CETemperature 75 °F / °C

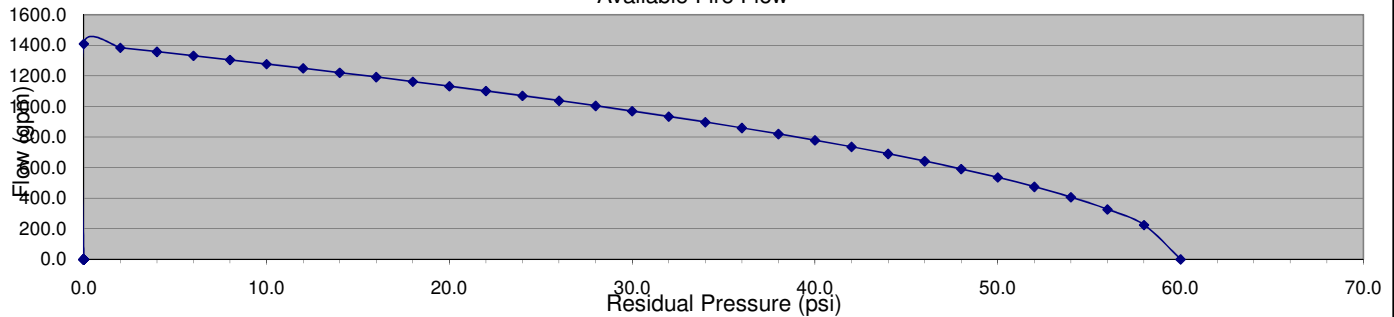
Flow Hydrant

2302Diameter 2.5 inchesCoefficient 0.77Pitot 20 psiFlow at Residual Pressure 642 gpmMins/flowed 2 Water Used 172 cubic feet

Gage (test) Hydrant

2301Static 60 psiResidual 46 psiFlow available at 20psi residual 1132 gpm

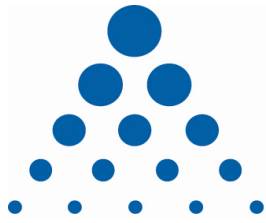
Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1357
2	203	29	773	56	1074	58	224	2	1383
3	249	30	786	57	1084	56	326	0	1409
4	287	31	799	58	1093	54	406	-	-
5	321	32	812	59	1103	52	475	-	-
6	352	33	825	60	1112	50	535	-	-
7	380	34	837	61	1121	48	591	-	-
8	406	35	849	62	1130	46	642	-	-
9	431	36	861	63	1139	44	690	-	-
10	454	37	873	64	1148	42	735	-	-
11	476	38	885	65	1157	40	778	-	-
12	497	39	897	66	1166	38	819	-	-
13	518	40	908	67	1175	36	859	-	-
14	537	41	919	68	1184	34	897	-	-
15	556	42	930	69	1192	32	933	-	-
16	574	43	941	70	1201	30	969	-	-
17	592	44	952	71	1210	28	1003	-	-
18	609	45	963	72	1218	26	1037	-	-
19	626	46	974	73	1227	24	1069	-	-
20	642	47	984	74	1235	22	1101	-	-
21	658	48	995	75	1243	20	1132	-	-
22	673	49	1005	76	1251	18	1162	-	-
23	688	50	1015	77	1260	16	1192	-	-
24	703	51	1025	78	1268	14	1220	-	-
25	718	52	1035	79	1276	12	1249	-	-
26	732	53	1045	80	1284	10	1277	-	-
27	746	54	1055	81	1292	8	1304	-	-
28	760	55	1065	82	1300	6	1331	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/21/09Time 11:45Weather Clear

Flusher / Tester

Prism CETemperature 75 °F / °C

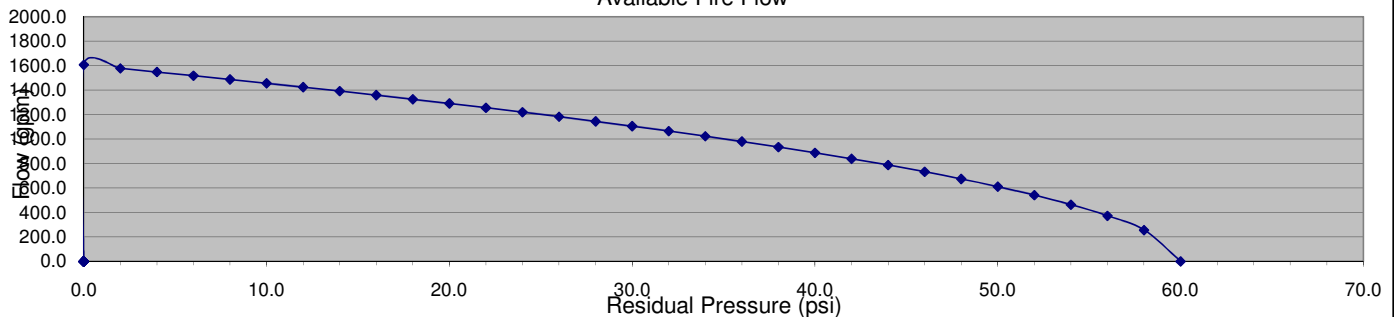
Flow Hydrant

2303Diameter 2.5 inchesCoefficient 0.77Pitot 22 psiFlow at Residual Pressure 673 gpmMins/flowed 2 Water Used 180 cubic feet

Gage (test) Hydrant

2301Static 60 psiResidual 48 psiFlow available at 20psi residual 1290 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1547
2	203	29	773	56	1074	58	256	2	1577
3	249	30	786	57	1084	56	372	0	1606
4	287	31	799	58	1093	54	463	-	-
5	321	32	812	59	1103	52	541	-	-
6	352	33	825	60	1112	50	610	-	-
7	380	34	837	61	1121	48	673	-	-
8	406	35	849	62	1130	46	732	-	-
9	431	36	861	63	1139	44	787	-	-
10	454	37	873	64	1148	42	838	-	-
11	476	38	885	65	1157	40	887	-	-
12	497	39	897	66	1166	38	934	-	-
13	518	40	908	67	1175	36	979	-	-
14	537	41	919	68	1184	34	1022	-	-
15	556	42	930	69	1192	32	1064	-	-
16	574	43	941	70	1201	30	1104	-	-
17	592	44	952	71	1210	28	1144	-	-
18	609	45	963	72	1218	26	1182	-	-
19	626	46	974	73	1227	24	1219	-	-
20	642	47	984	74	1235	22	1255	-	-
21	658	48	995	75	1243	20	1290	-	-
22	673	49	1005	76	1251	18	1324	-	-
23	688	50	1015	77	1260	16	1358	-	-
24	703	51	1025	78	1268	14	1391	-	-
25	718	52	1035	79	1276	12	1423	-	-
26	732	53	1045	80	1284	10	1455	-	-
27	746	54	1055	81	1292	8	1486	-	-
28	760	55	1065	82	1300	6	1517	-	-



Old Dominion Utility Services, Inc.

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FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09Time 10:50Weather Clear

Flusher / Tester

Prism CETemperature 80 °F / °C

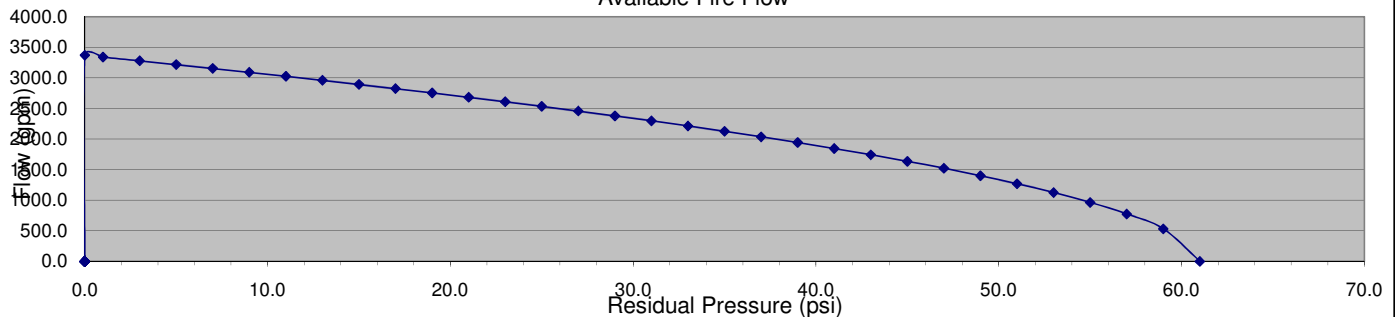
Flow Hydrant

2304Diameter 2.5 inchesCoefficient 0.77Pitot 29 psiFlow at Residual Pressure 773 gpmMins/flowed 2 Water Used 207 cubic feet

Gage (test) Hydrant

2308Static 61 psiResidual 57 psiFlow available at 20psi residual 2717 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	61	0	5	3215
2	203	29	773	56	1074	59	532	3	3276
3	249	30	786	57	1084	57	773	1	3337
4	287	31	799	58	1093	55	962	0	3367
5	321	32	812	59	1103	53	1124	-	-
6	352	33	825	60	1112	51	1268	-	-
7	380	34	837	61	1121	49	1399	-	-
8	406	35	849	62	1130	47	1521	-	-
9	431	36	861	63	1139	45	1634	-	-
10	454	37	873	64	1148	43	1742	-	-
11	476	38	885	65	1157	41	1844	-	-
12	497	39	897	66	1166	39	1941	-	-
13	518	40	908	67	1175	37	2034	-	-
14	537	41	919	68	1184	35	2124	-	-
15	556	42	930	69	1192	33	2211	-	-
16	574	43	941	70	1201	31	2295	-	-
17	592	44	952	71	1210	29	2376	-	-
18	609	45	963	72	1218	27	2455	-	-
19	626	46	974	73	1227	25	2532	-	-
20	642	47	984	74	1235	23	2607	-	-
21	658	48	995	75	1243	21	2681	-	-
22	673	49	1005	76	1251	19	2752	-	-
23	688	50	1015	77	1260	17	2822	-	-
24	703	51	1025	78	1268	15	2891	-	-
25	718	52	1035	79	1276	13	2958	-	-
26	732	53	1045	80	1284	11	3024	-	-
27	746	54	1055	81	1292	9	3089	-	-
28	760	55	1065	82	1300	7	3152	-	-



Old Dominion

Utility Services, Inc.

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FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09

Time 3:00

Weather Clear

Flusher / Tester

Prism CE

Temperature 90 °F / °C

Flow Hydrant

2315

Diameter 2.5 inches

Coefficient 0.77

Pitot 30 psi

Flow at Residual Pressure 786 gpm

Mins/flowed 2 Water Used 210 cubic feet

Gage (test) Hydrant

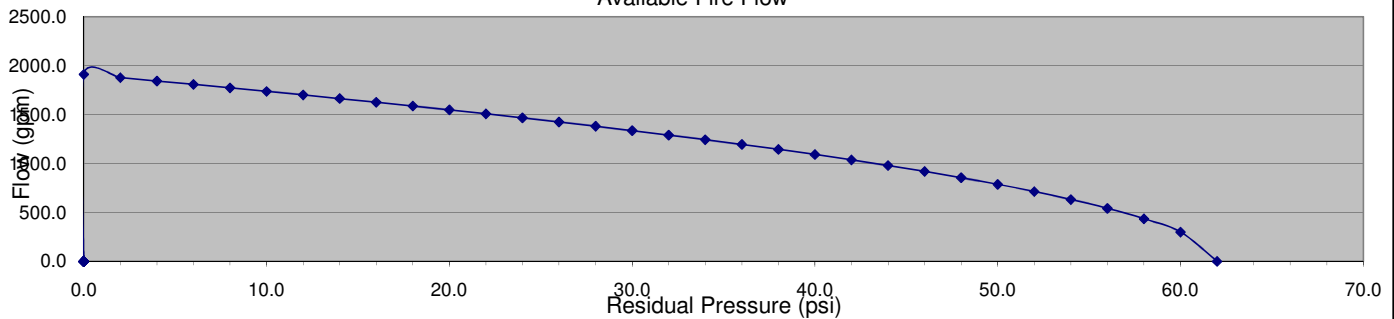
2320

Static 62 psi

Residual 50 psi

Flow available at 20psi residual 1547 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	62	0	6	1807
2	203	29	773	56	1074	60	299	4	1841
3	249	30	786	57	1084	58	434	2	1875
4	287	31	799	58	1093	56	541	0	1909
5	321	32	812	59	1103	54	632	-	-
6	352	33	825	60	1112	52	713	-	-
7	380	34	837	61	1121	50	786	-	-
8	406	35	849	62	1130	48	855	-	-
9	431	36	861	63	1139	46	918	-	-
10	454	37	873	64	1148	44	979	-	-
11	476	38	885	65	1157	42	1036	-	-
12	497	39	897	66	1166	40	1091	-	-
13	518	40	908	67	1175	38	1143	-	-
14	537	41	919	68	1184	36	1194	-	-
15	556	42	930	69	1192	34	1242	-	-
16	574	43	941	70	1201	32	1290	-	-
17	592	44	952	71	1210	30	1335	-	-
18	609	45	963	72	1218	28	1380	-	-
19	626	46	974	73	1227	26	1423	-	-
20	642	47	984	74	1235	24	1465	-	-
21	658	48	995	75	1243	22	1506	-	-
22	673	49	1005	76	1251	20	1547	-	-
23	688	50	1015	77	1260	18	1586	-	-
24	703	51	1025	78	1268	16	1624	-	-
25	718	52	1035	79	1276	14	1662	-	-
26	732	53	1045	80	1284	12	1699	-	-
27	746	54	1055	81	1292	10	1736	-	-
28	760	55	1065	82	1300	8	1771	-	-



Old Dominion

Utility Services, Inc.

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FIRE HYDRANT FIRE FLOW TEST

Date 04/28/09

Time 3:10

Weather Clear

Flusher / Tester

Prism CE

Temperature 90 °F / °C

Flow Hydrant

2320

Diameter 2.5 inches

Coefficient 0.77

Pitot 32 psi

Flow at Residual Pressure 812 gpm

Mins/flowed 2 Water Used 217 cubic feet

Gage (test) Hydrant

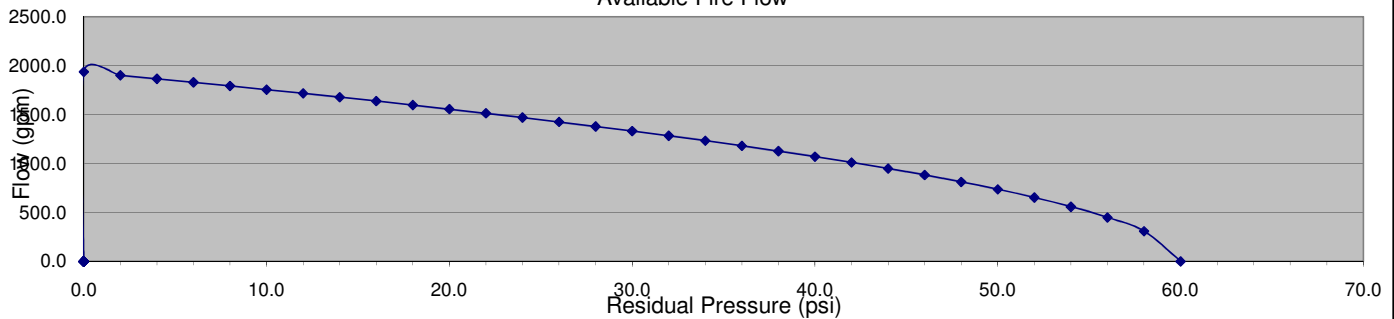
2315

Static 60 psi

Residual 48 psi

Flow available at 20psi residual 1556 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1866
2	203	29	773	56	1074	58	309	2	1901
3	249	30	786	57	1084	56	449	0	1937
4	287	31	799	58	1093	54	559	-	-
5	321	32	812	59	1103	52	652	-	-
6	352	33	825	60	1112	50	736	-	-
7	380	34	837	61	1121	48	812	-	-
8	406	35	849	62	1130	46	883	-	-
9	431	36	861	63	1139	44	949	-	-
10	454	37	873	64	1148	42	1011	-	-
11	476	38	885	65	1157	40	1070	-	-
12	497	39	897	66	1166	38	1127	-	-
13	518	40	908	67	1175	36	1181	-	-
14	537	41	919	68	1184	34	1233	-	-
15	556	42	930	69	1192	32	1283	-	-
16	574	43	941	70	1201	30	1332	-	-
17	592	44	952	71	1210	28	1379	-	-
18	609	45	963	72	1218	26	1425	-	-
19	626	46	974	73	1227	24	1470	-	-
20	642	47	984	74	1235	22	1513	-	-
21	658	48	995	75	1243	20	1556	-	-
22	673	49	1005	76	1251	18	1597	-	-
23	688	50	1015	77	1260	16	1638	-	-
24	703	51	1025	78	1268	14	1678	-	-
25	718	52	1035	79	1276	12	1717	-	-
26	732	53	1045	80	1284	10	1755	-	-
27	746	54	1055	81	1292	8	1793	-	-
28	760	55	1065	82	1300	6	1830	-	-



Old Dominion

Utility Services, Inc.

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FIRE HYDRANT FIRE FLOW TEST

Date 04/27/09

Time 10:40

Weather Clear

Flusher / Tester

Prism CE

Temperature 80 °F / °C

Flow Hydrant

2321

Diameter 2.5 inches

Coefficient 0.77

Pitot 32 psi

Flow at Residual Pressure 812 gpm

Mins/flowed 2 Water Used 217 cubic feet

Gage (test) Hydrant

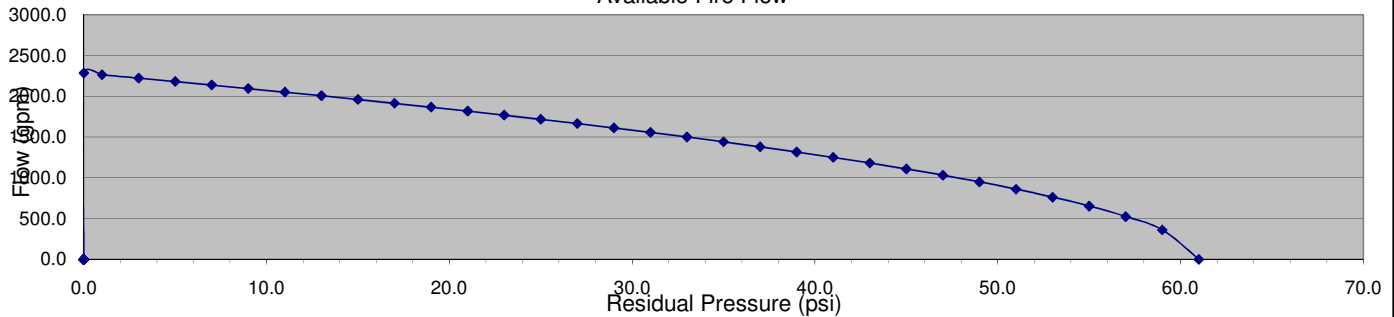
2319

Static 61 psi

Residual 52 psi

Flow available at 20psi residual 1842 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	61	0	5	2179
2	203	29	773	56	1074	59	360	3	2221
3	249	30	786	57	1084	57	524	1	2262
4	287	31	799	58	1093	55	652	0	2282
5	321	32	812	59	1103	53	762	-	-
6	352	33	825	60	1112	51	860	-	-
7	380	34	837	61	1121	49	949	-	-
8	406	35	849	62	1130	47	1031	-	-
9	431	36	861	63	1139	45	1108	-	-
10	454	37	873	64	1148	43	1181	-	-
11	476	38	885	65	1157	41	1250	-	-
12	497	39	897	66	1166	39	1316	-	-
13	518	40	908	67	1175	37	1379	-	-
14	537	41	919	68	1184	35	1440	-	-
15	556	42	930	69	1192	33	1499	-	-
16	574	43	941	70	1201	31	1556	-	-
17	592	44	952	71	1210	29	1611	-	-
18	609	45	963	72	1218	27	1665	-	-
19	626	46	974	73	1227	25	1717	-	-
20	642	47	984	74	1235	23	1768	-	-
21	658	48	995	75	1243	21	1817	-	-
22	673	49	1005	76	1251	19	1866	-	-
23	688	50	1015	77	1260	17	1913	-	-
24	703	51	1025	78	1268	15	1960	-	-
25	718	52	1035	79	1276	13	2005	-	-
26	732	53	1045	80	1284	11	2050	-	-
27	746	54	1055	81	1292	9	2094	-	-
28	760	55	1065	82	1300	7	2137	-	-



Old Dominion

Utility Services, Inc.

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FIRE HYDRANT FIRE FLOW TEST

Date 04/27/09Time 11:15Weather Clear

Valve Closed?

Flusher / Tester

Prism CETemperature 85 °F / °C

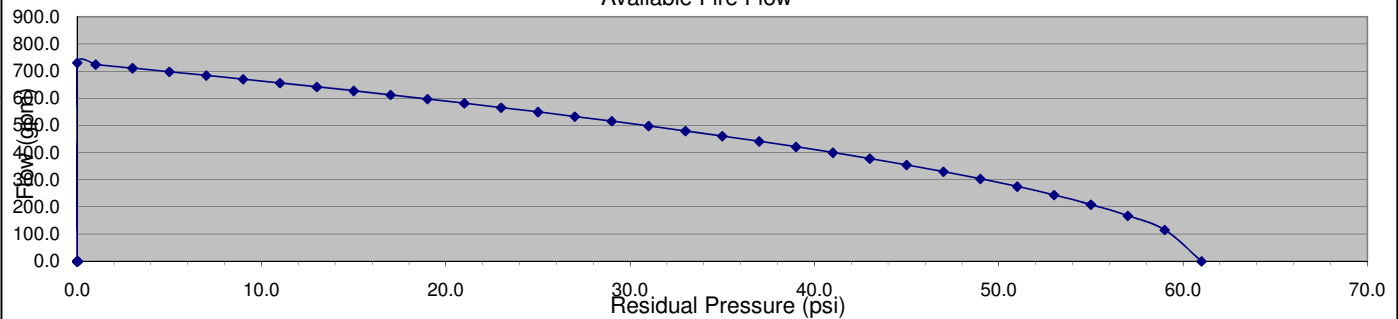
Flow Hydrant

2323Diameter 2.5 inchesCoefficient 0.77Pitot 1 psiFlow at Residual Pressure 144 gpmMins/flowed 2 Water Used 38 cubic feet

Gage (test) Hydrant

2319Static 61 psiResidual 58 psiFlow available at 20psi residual 589 gpm

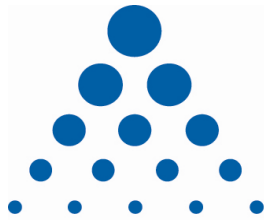
Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	61	0	5	697
2	203	29	773	56	1074	59	115	3	711
3	249	30	786	57	1084	57	168	1	724
4	287	31	799	58	1093	55	209	0	730
5	321	32	812	59	1103	53	244	-	-
6	352	33	825	60	1112	51	275	-	-
7	380	34	837	61	1121	49	303	-	-
8	406	35	849	62	1130	47	330	-	-
9	431	36	861	63	1139	45	354	-	-
10	454	37	873	64	1148	43	378	-	-
11	476	38	885	65	1157	41	400	-	-
12	497	39	897	66	1166	39	421	-	-
13	518	40	908	67	1175	37	441	-	-
14	537	41	919	68	1184	35	461	-	-
15	556	42	930	69	1192	33	480	-	-
16	574	43	941	70	1201	31	498	-	-
17	592	44	952	71	1210	29	515	-	-
18	609	45	963	72	1218	27	533	-	-
19	626	46	974	73	1227	25	549	-	-
20	642	47	984	74	1235	23	566	-	-
21	658	48	995	75	1243	21	581	-	-
22	673	49	1005	76	1251	19	597	-	-
23	688	50	1015	77	1260	17	612	-	-
24	703	51	1025	78	1268	15	627	-	-
25	718	52	1035	79	1276	13	642	-	-
26	732	53	1045	80	1284	11	656	-	-
27	746	54	1055	81	1292	9	670	-	-
28	760	55	1065	82	1300	7	684	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 04/29/09Time 9:35Weather Clear

Flusher / Tester

Prism CETemperature 70 °F / °C

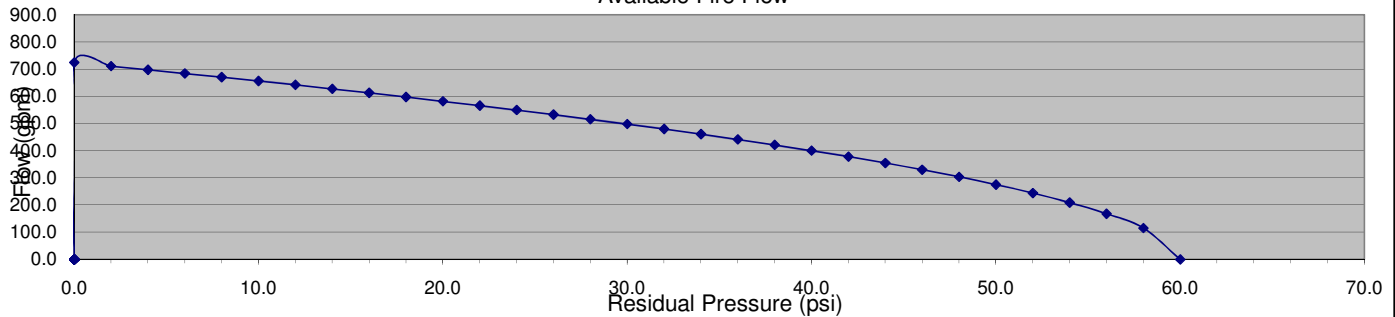
Flow Hydrant

2324Diameter 2.5 inchesCoefficient 0.77Pitot 1 psiFlow at Residual Pressure 144 gpmMins/flowed 2 Water Used 38 cubic feet

Gage (test) Hydrant

1715Static 60 psiResidual 57 psiFlow available at 20psi residual 581 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	697
2	203	29	773	56	1074	58	115	2	711
3	249	30	786	57	1084	56	168	0	724
4	287	31	799	58	1093	54	209	-	-
5	321	32	812	59	1103	52	244	-	-
6	352	33	825	60	1112	50	275	-	-
7	380	34	837	61	1121	48	303	-	-
8	406	35	849	62	1130	46	330	-	-
9	431	36	861	63	1139	44	354	-	-
10	454	37	873	64	1148	42	378	-	-
11	476	38	885	65	1157	40	400	-	-
12	497	39	897	66	1166	38	421	-	-
13	518	40	908	67	1175	36	441	-	-
14	537	41	919	68	1184	34	461	-	-
15	556	42	930	69	1192	32	480	-	-
16	574	43	941	70	1201	30	498	-	-
17	592	44	952	71	1210	28	515	-	-
18	609	45	963	72	1218	26	533	-	-
19	626	46	974	73	1227	24	549	-	-
20	642	47	984	74	1235	22	566	-	-
21	658	48	995	75	1243	20	581	-	-
22	673	49	1005	76	1251	18	597	-	-
23	688	50	1015	77	1260	16	612	-	-
24	703	51	1025	78	1268	14	627	-	-
25	718	52	1035	79	1276	12	642	-	-
26	732	53	1045	80	1284	10	656	-	-
27	746	54	1055	81	1292	8	670	-	-
28	760	55	1065	82	1300	6	684	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 06/25/09

Time 10:00

Weather Sunny

Flusher / Tester

Prism CE

Temperature 75 °F / °C

Flow Hydrant

2701

Diameter 2.5 inches

Coefficient 0.77

Pitot 27.5 psi

Flow at Residual Pressure 753 gpm

Mins/flowed 2 Water Used 201 cubic feet

Gage (test) Hydrant

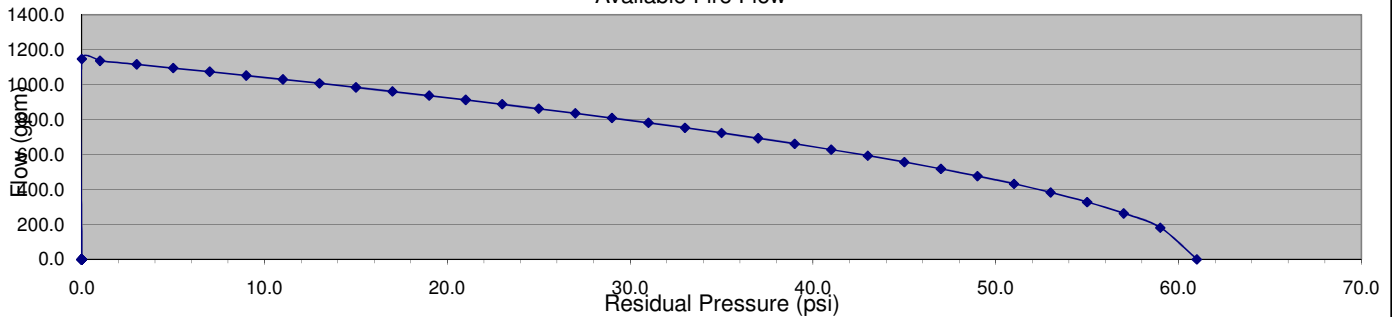
2704

Static 61 psi

Residual 33 psi

Flow available at 20psi residual 925 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	61	0	5	1095
2	203	29	773	56	1074	59	181	3	1116
3	249	30	786	57	1084	57	263	1	1136
4	287	31	799	58	1093	55	328	0	1146
5	321	32	812	59	1103	53	383	-	-
6	352	33	825	60	1112	51	432	-	-
7	380	34	837	61	1121	49	476	-	-
8	406	35	849	62	1130	47	518	-	-
9	431	36	861	63	1139	45	556	-	-
10	454	37	873	64	1148	43	593	-	-
11	476	38	885	65	1157	41	628	-	-
12	497	39	897	66	1166	39	661	-	-
13	518	40	908	67	1175	37	693	-	-
14	537	41	919	68	1184	35	723	-	-
15	556	42	930	69	1192	33	753	-	-
16	574	43	941	70	1201	31	781	-	-
17	592	44	952	71	1210	29	809	-	-
18	609	45	963	72	1218	27	836	-	-
19	626	46	974	73	1227	25	862	-	-
20	642	47	984	74	1235	23	888	-	-
21	658	48	995	75	1243	21	913	-	-
22	673	49	1005	76	1251	19	937	-	-
23	688	50	1015	77	1260	17	961	-	-
24	703	51	1025	78	1268	15	984	-	-
25	718	52	1035	79	1276	13	1007	-	-
26	732	53	1045	80	1284	11	1030	-	-
27	746	54	1055	81	1292	9	1052	-	-
28	760	55	1065	82	1300	7	1073	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 06/25/09Time 9:45Weather Sunny

Flusher / Tester

Prism CETemperature 75 °F / °C

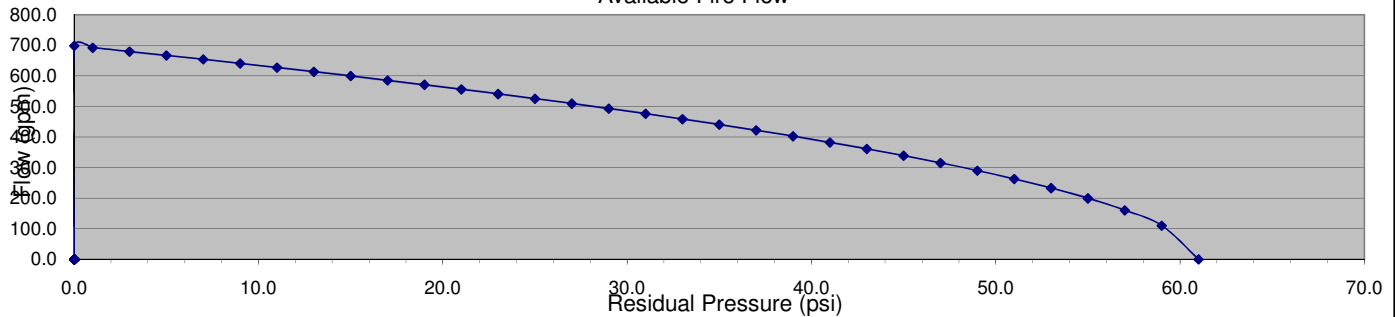
Flow Hydrant

2703Diameter 2.5 inchesCoefficient 0.77Pitot 15 psiFlow at Residual Pressure 556 gpmMins/flowed 2 Water Used 149 cubic feet

Gage (test) Hydrant

2704Static 61 psiResidual 21 psiFlow available at 20psi residual 563 gpm

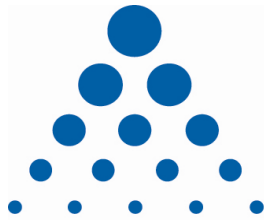
Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	61	0	5	667
2	203	29	773	56	1074	59	110	3	680
3	249	30	786	57	1084	57	160	1	692
4	287	31	799	58	1093	55	200	0	698
5	321	32	812	59	1103	53	233	-	-
6	352	33	825	60	1112	51	263	-	-
7	380	34	837	61	1121	49	290	-	-
8	406	35	849	62	1130	47	315	-	-
9	431	36	861	63	1139	45	339	-	-
10	454	37	873	64	1148	43	361	-	-
11	476	38	885	65	1157	41	382	-	-
12	497	39	897	66	1166	39	403	-	-
13	518	40	908	67	1175	37	422	-	-
14	537	41	919	68	1184	35	441	-	-
15	556	42	930	69	1192	33	459	-	-
16	574	43	941	70	1201	31	476	-	-
17	592	44	952	71	1210	29	493	-	-
18	609	45	963	72	1218	27	509	-	-
19	626	46	974	73	1227	25	525	-	-
20	642	47	984	74	1235	23	541	-	-
21	658	48	995	75	1243	21	556	-	-
22	673	49	1005	76	1251	19	571	-	-
23	688	50	1015	77	1260	17	585	-	-
24	703	51	1025	78	1268	15	600	-	-
25	718	52	1035	79	1276	13	614	-	-
26	732	53	1045	80	1284	11	627	-	-
27	746	54	1055	81	1292	9	641	-	-
28	760	55	1065	82	1300	7	654	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 06/25/09Time 10:15Weather Sunny

Flusher / Tester

Prism CETemperature 75 °F / °C

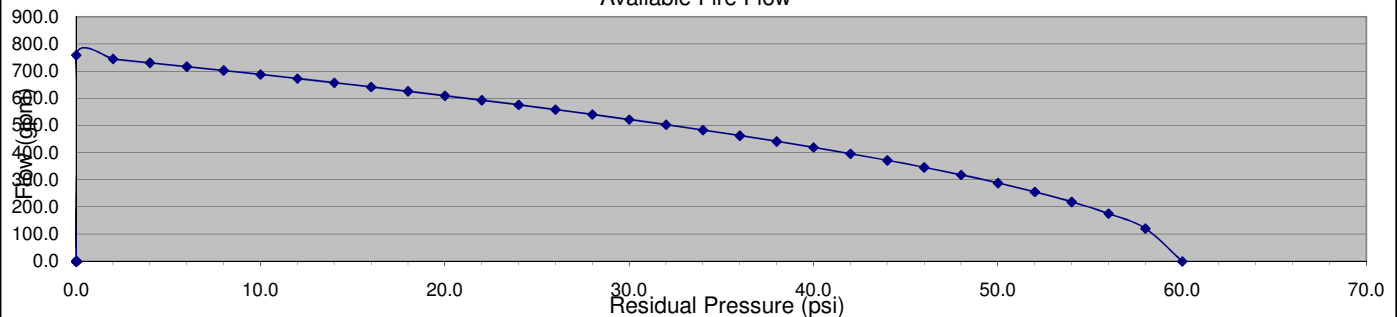
Flow Hydrant

2704Diameter 2.5 inchesCoefficient 0.77Pitot 17.5 psiFlow at Residual Pressure 601 gpmMins/flowed 2 Water Used 161 cubic feet

Gage (test) Hydrant

2703Static 60 psiResidual 21 psiFlow available at 20psi residual 609 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	730
2	203	29	773	56	1074	58	121	2	744
3	249	30	786	57	1084	56	176	0	758
4	287	31	799	58	1093	54	219	-	-
5	321	32	812	59	1103	52	255	-	-
6	352	33	825	60	1112	50	288	-	-
7	380	34	837	61	1121	48	318	-	-
8	406	35	849	62	1130	46	345	-	-
9	431	36	861	63	1139	44	371	-	-
10	454	37	873	64	1148	42	396	-	-
11	476	38	885	65	1157	40	419	-	-
12	497	39	897	66	1166	38	441	-	-
13	518	40	908	67	1175	36	462	-	-
14	537	41	919	68	1184	34	482	-	-
15	556	42	930	69	1192	32	502	-	-
16	574	43	941	70	1201	30	521	-	-
17	592	44	952	71	1210	28	540	-	-
18	609	45	963	72	1218	26	558	-	-
19	626	46	974	73	1227	24	575	-	-
20	642	47	984	74	1235	22	592	-	-
21	658	48	995	75	1243	20	609	-	-
22	673	49	1005	76	1251	18	625	-	-
23	688	50	1015	77	1260	16	641	-	-
24	703	51	1025	78	1268	14	657	-	-
25	718	52	1035	79	1276	12	672	-	-
26	732	53	1045	80	1284	10	687	-	-
27	746	54	1055	81	1292	8	701	-	-
28	760	55	1065	82	1300	6	716	-	-

Friday, July 23, 2010



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 05/07/09

Time 2:00

Weather Sunny

Flusher / Tester

Prism CE

Temperature 80 °F / °C

Flow Hydrant

2709

Diameter 2.5 inches

Coefficient 0.77

Pitot 29 psi

Flow at Residual Pressure 773 gpm

Mins/flowed 2 Water Used 207 cubic feet

Gage (test) Hydrant

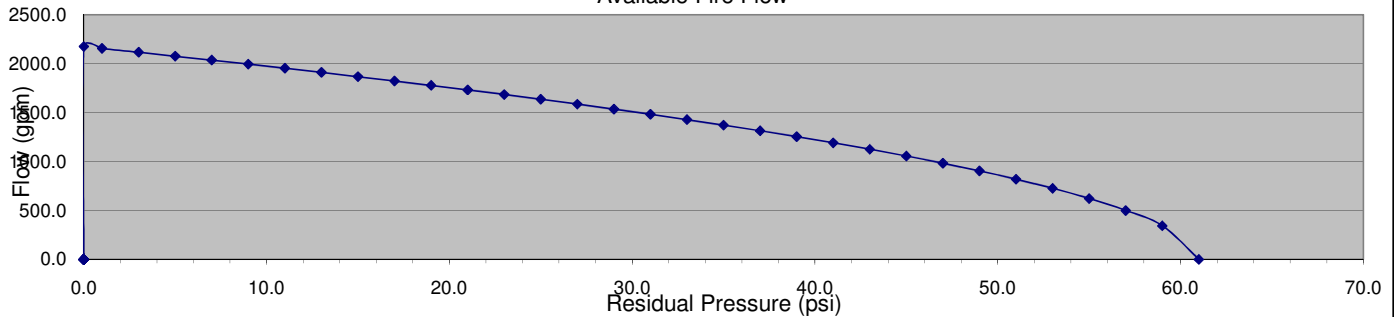
2722

Static 61 psi

Residual 52 psi

Flow available at 20psi residual 1753 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	61	0	5	2075
2	203	29	773	56	1074	59	343	3	2114
3	249	30	786	57	1084	57	499	1	2153
4	287	31	799	58	1093	55	621	0	2173
5	321	32	812	59	1103	53	725	-	-
6	352	33	825	60	1112	51	818	-	-
7	380	34	837	61	1121	49	903	-	-
8	406	35	849	62	1130	47	981	-	-
9	431	36	861	63	1139	45	1055	-	-
10	454	37	873	64	1148	43	1124	-	-
11	476	38	885	65	1157	41	1190	-	-
12	497	39	897	66	1166	39	1253	-	-
13	518	40	908	67	1175	37	1313	-	-
14	537	41	919	68	1184	35	1371	-	-
15	556	42	930	69	1192	33	1427	-	-
16	574	43	941	70	1201	31	1481	-	-
17	592	44	952	71	1210	29	1534	-	-
18	609	45	963	72	1218	27	1585	-	-
19	626	46	974	73	1227	25	1634	-	-
20	642	47	984	74	1235	23	1683	-	-
21	658	48	995	75	1243	21	1730	-	-
22	673	49	1005	76	1251	19	1776	-	-
23	688	50	1015	77	1260	17	1821	-	-
24	703	51	1025	78	1268	15	1866	-	-
25	718	52	1035	79	1276	13	1909	-	-
26	732	53	1045	80	1284	11	1952	-	-
27	746	54	1055	81	1292	9	1993	-	-
28	760	55	1065	82	1300	7	2034	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 05/07/09

Time 11:30

Weather Cloudy

Flusher / Tester

Prism CE

Temperature 70 °F / °C

Flow Hydrant

2741

Diameter 2.5 inches

Coefficient 0.77

Pitot 33 psi

Flow at Residual Pressure 825 gpm

Mins/flowed 2 Water Used 221 cubic feet

Gage (test) Hydrant

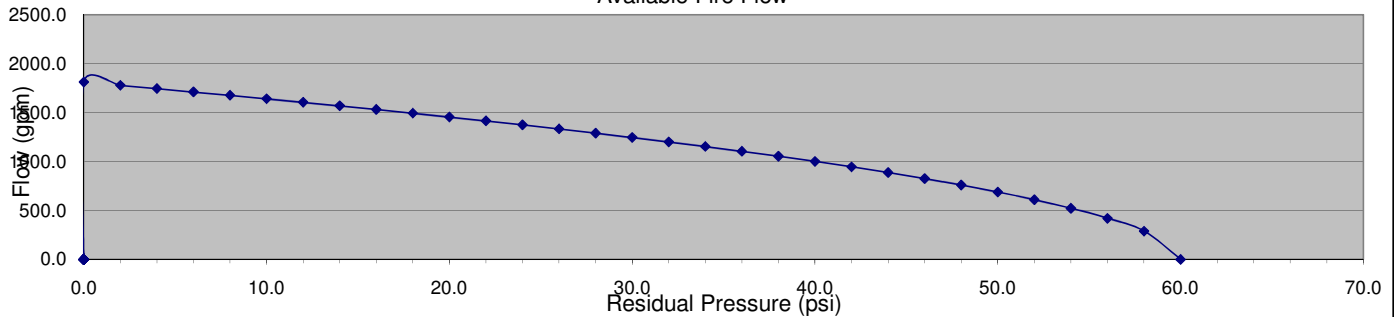
2708

Static 60 psi

Residual 46 psi

Flow available at 20psi residual 1454 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	60	0	4	1743
2	203	29	773	56	1074	58	288	2	1777
3	249	30	786	57	1084	56	419	0	1810
4	287	31	799	58	1093	54	522	-	-
5	321	32	812	59	1103	52	610	-	-
6	352	33	825	60	1112	50	688	-	-
7	380	34	837	61	1121	48	759	-	-
8	406	35	849	62	1130	46	825	-	-
9	431	36	861	63	1139	44	886	-	-
10	454	37	873	64	1148	42	945	-	-
11	476	38	885	65	1157	40	1000	-	-
12	497	39	897	66	1166	38	1053	-	-
13	518	40	908	67	1175	36	1103	-	-
14	537	41	919	68	1184	34	1152	-	-
15	556	42	930	69	1192	32	1199	-	-
16	574	43	941	70	1201	30	1245	-	-
17	592	44	952	71	1210	28	1289	-	-
18	609	45	963	72	1218	26	1332	-	-
19	626	46	974	73	1227	24	1373	-	-
20	642	47	984	74	1235	22	1414	-	-
21	658	48	995	75	1243	20	1454	-	-
22	673	49	1005	76	1251	18	1493	-	-
23	688	50	1015	77	1260	16	1531	-	-
24	703	51	1025	78	1268	14	1568	-	-
25	718	52	1035	79	1276	12	1604	-	-
26	732	53	1045	80	1284	10	1640	-	-
27	746	54	1055	81	1292	8	1675	-	-
28	760	55	1065	82	1300	6	1709	-	-



Old Dominion

Utility Services, Inc.

A Subsidiary of American States Utility Services, Inc.

FIRE HYDRANT FIRE FLOW TEST

Date 05/07/09

Time 11:50

Weather Sunny

Flusher / Tester

Prism CE

Temperature 75 °F / °C

Flow Hydrant

2743

Diameter 2.5 inches

Coefficient 0.77

Pitot 34 psi

Flow at Residual Pressure 837 gpm

Mins/flowed 2 Water Used 224 cubic feet

Gage (test) Hydrant

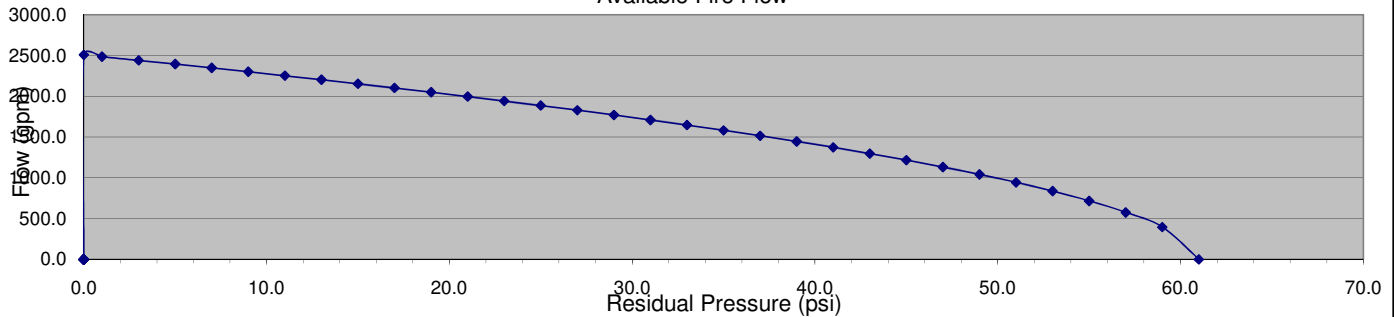
2722

Static 61 psi

Residual 53 psi

Flow available at 20psi residual 2023 gpm

Available Fire Flow



Pitot Chart

Flow Available at Residual Pressure

psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	61	0	5	2394
2	203	29	773	56	1074	59	396	3	2440
3	249	30	786	57	1084	57	576	1	2485
4	287	31	799	58	1093	55	717	0	2507
5	321	32	812	59	1103	53	837	-	-
6	352	33	825	60	1112	51	944	-	-
7	380	34	837	61	1121	49	1042	-	-
8	406	35	849	62	1130	47	1132	-	-
9	431	36	861	63	1139	45	1217	-	-
10	454	37	873	64	1148	43	1297	-	-
11	476	38	885	65	1157	41	1373	-	-
12	497	39	897	66	1166	39	1445	-	-
13	518	40	908	67	1175	37	1515	-	-
14	537	41	919	68	1184	35	1582	-	-
15	556	42	930	69	1192	33	1646	-	-
16	574	43	941	70	1201	31	1709	-	-
17	592	44	952	71	1210	29	1770	-	-
18	609	45	963	72	1218	27	1828	-	-
19	626	46	974	73	1227	25	1886	-	-
20	642	47	984	74	1235	23	1942	-	-
21	658	48	995	75	1243	21	1996	-	-
22	673	49	1005	76	1251	19	2050	-	-
23	688	50	1015	77	1260	17	2102	-	-
24	703	51	1025	78	1268	15	2153	-	-
25	718	52	1035	79	1276	13	2203	-	-
26	732	53	1045	80	1284	11	2252	-	-
27	746	54	1055	81	1292	9	2300	-	-
28	760	55	1065	82	1300	7	2347	-	-

APPENDIX E Environmental Information

Not Used



REQUEST FOR PROPOSAL



APPENDIX-F

ARCHITECTURAL THEME

CONCEPTUAL AESTHETIC CONSIDERATIONS

(FOR INFORMATION ONLY)

Photographs depict a building which identifies the desired project look and feel. It should be noted that the photographs are NOT intended to illustrate the design that the Design Build Designer MUST follow.

DINING FACILITY



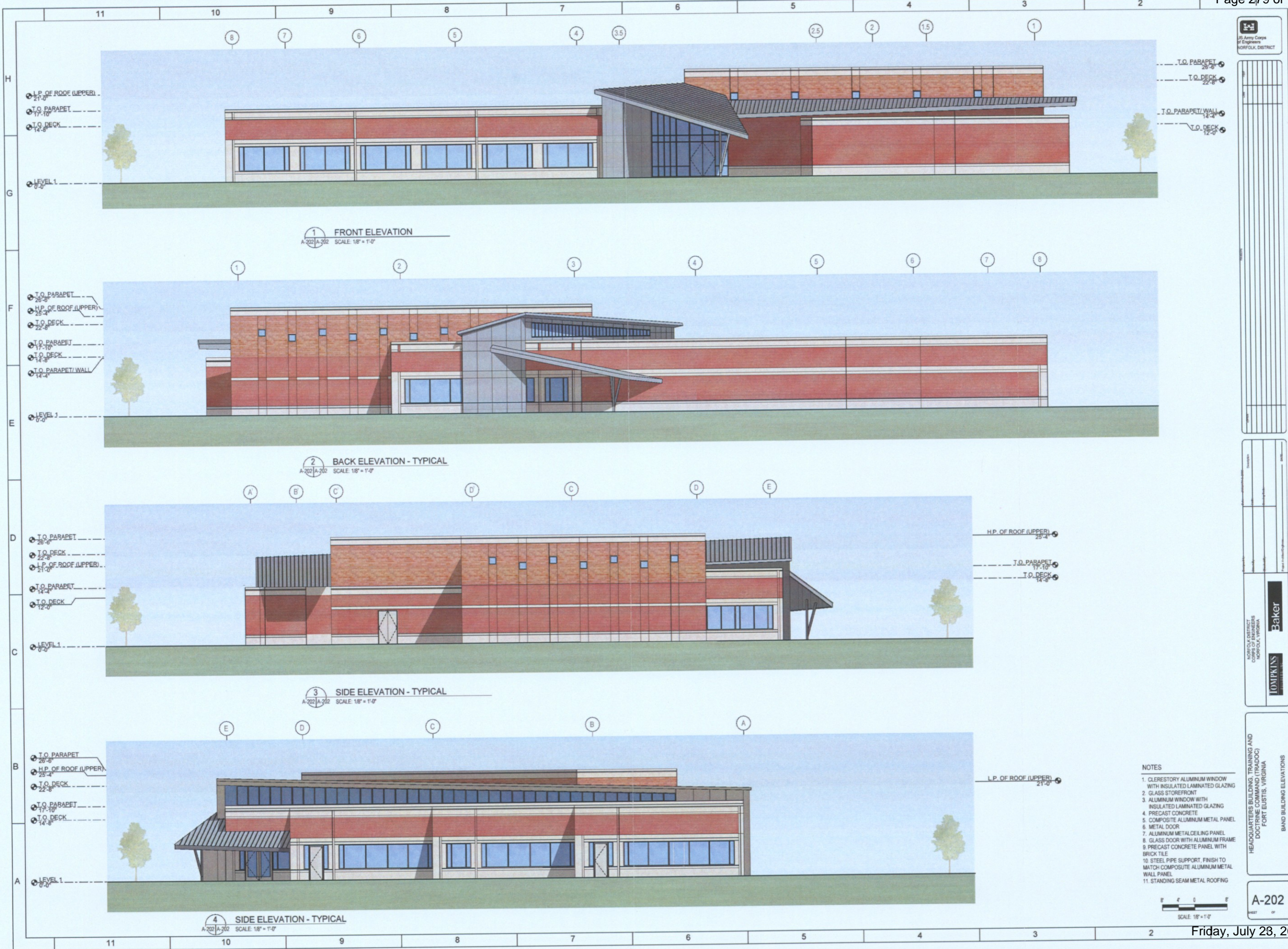
FRONT ELEVATION
1/8" = 1' 0"



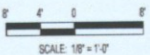
SIDE ELEVATION
1/8" = 1' 0"







- NOTES
1. CLERESTORY ALUMINUM WINDOW WITH INSULATED LAMINATED GLAZING
 2. GLASS STOREFRONT
 3. ALUMINUM WINDOW WITH INSULATED LAMINATED GLAZING
 4. PRECAST CONCRETE
 5. COMPOSITE ALUMINUM METAL PANEL
 6. METAL DOOR
 7. ALUMINUM METAL CEILING PANEL
 8. GLASS DOOR WITH ALUMINUM FRAME
 9. PRECAST CONCRETE PANEL WITH BRICK TILE
 10. STEEL PIPE SUPPORT, FINISH TO MATCH COMPOSITE ALUMINUM METAL WALL PANEL
 11. STANDING SEAM METAL ROOFING



Project Information

Project Name	Headquarters Building, Training and Doctrine Command (TRADOC) Fort Eustis, Virginia
Project Number	A-202
Project Location	Norfolk District, Norfolk, Virginia
Project Manager	Baker
Project Engineer	Tompkins

Project Information

Project Name	Headquarters Building, Training and Doctrine Command (TRADOC) Fort Eustis, Virginia
Project Number	A-202
Project Location	Norfolk District, Norfolk, Virginia
Project Manager	Baker
Project Engineer	Tompkins

Project Information

Project Name	Headquarters Building, Training and Doctrine Command (TRADOC) Fort Eustis, Virginia
Project Number	A-202
Project Location	Norfolk District, Norfolk, Virginia
Project Manager	Baker
Project Engineer	Tompkins

APPENDIX G GIS Data

Not Used



REQUEST FOR PROPOSAL



APPENDIX-H

EXTERIOR SIGNAGE

EP 310-1-6a
01 Jun 06

Construction Project Identification Sign
FIGURE 1

Below are two samples of the Construction Project Identification sign showing how this panel is adaptable for use to identify either military (top) or civil works projects (bottom). The graphic format for this 4'x 6' sign panel follows the legend guidelines and layout as specified below. The large 4'x 4' section of the panel on the right is to be white with black legend. The 2'x 4' section of the sign on the left

with the full Corps Signature (reverse version) is to be screen-printed Communication Red on the white background. The designation of a sponsor in the area indicated is optional with Military or Civil Works construction signs. Signs may list one sponsoring entity. If agreement on a sponsor designation cannot be achieved, the area should be left blank.

This sign is to be placed with the Safety Performance sign shown on the following page. Mounting and fabrication details are provided on page 16-4.

Special applications or situations not covered in these guidelines should be referred to the district Sign Program Manager.

Legend Group 1: One- to two-line description of Corps relationship to project.

Color: White

Typeface: 1.25" Helvetica Regular

Maximum line length: 19"

Legend Group 2: Division or District Name (optional). Placed below 10.5" reverse Signature (6" Castle).

Color: White

Typeface: 1.25" Helvetica Regular

Legend Group 2a: One- to three-line identification of Military or Civil Works sponsor (optional). Place below Corps Signature to cross-align with Group 5a-b.

Color: White

Typeface: 1.25" Helvetica Regular

Maximum line length: 19"

Legend Group 3: One- to three-line project title legend describes the work being done under this contract.

Color: Black

Typeface: 3" Helvetica Bold

Maximum line length: 42"

Legend Group 4: One- to two-line identification of project or facility (civil works) or name of sponsoring department (military).

Color: Black

Typeface: 1.5" Helvetica Regular

Maximum line length: 42"

Cross-align the first line of Legend Group 4 with the first line of the Corps Signature (US Army Corps) as shown.

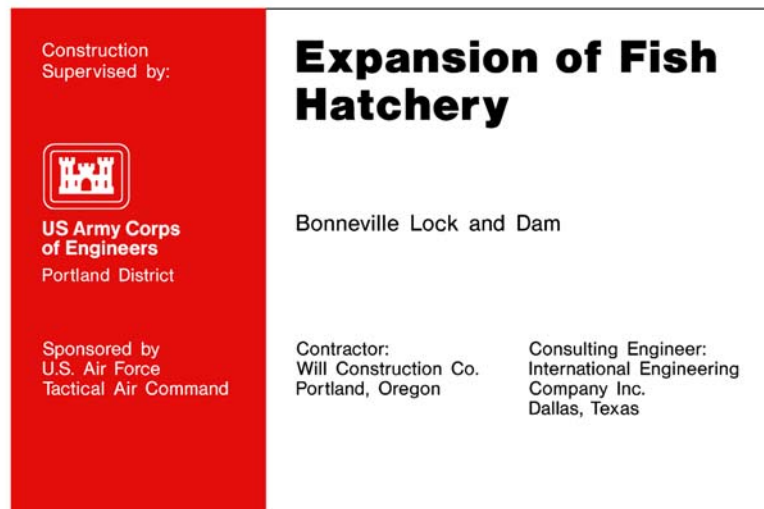
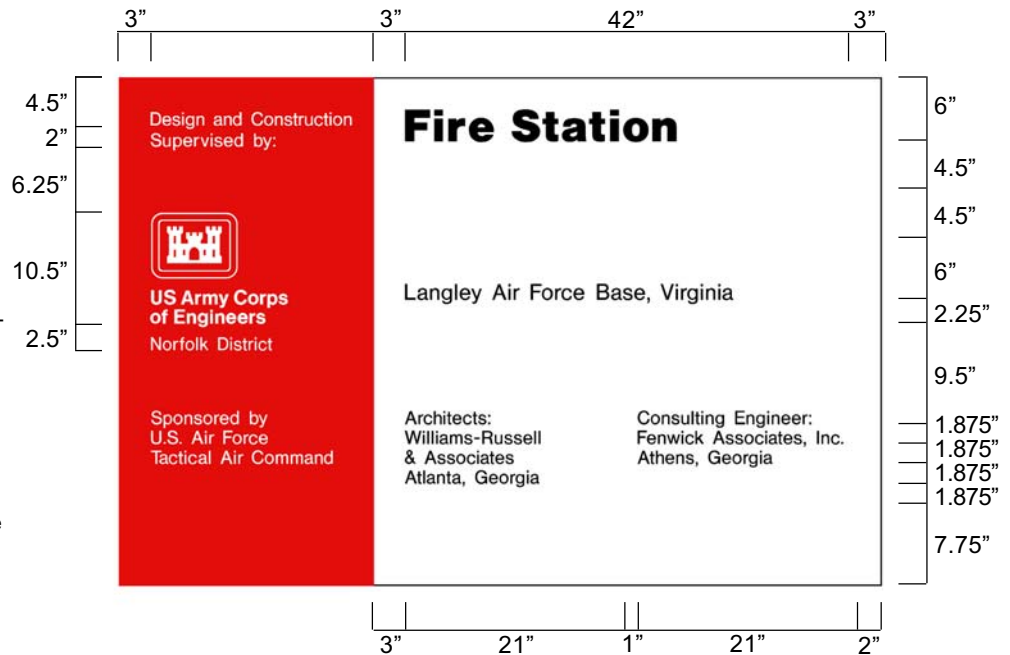
Legend Groups 5a-b: One- to five-line identification of prime contractors including: type (architect, general contractor, etc.), corporate or firm name, city, state. Use of Legend Group 5 is optional.

Color: Black

Typeface: 1.25" Helvetica Regular

Maximum line length: 21"

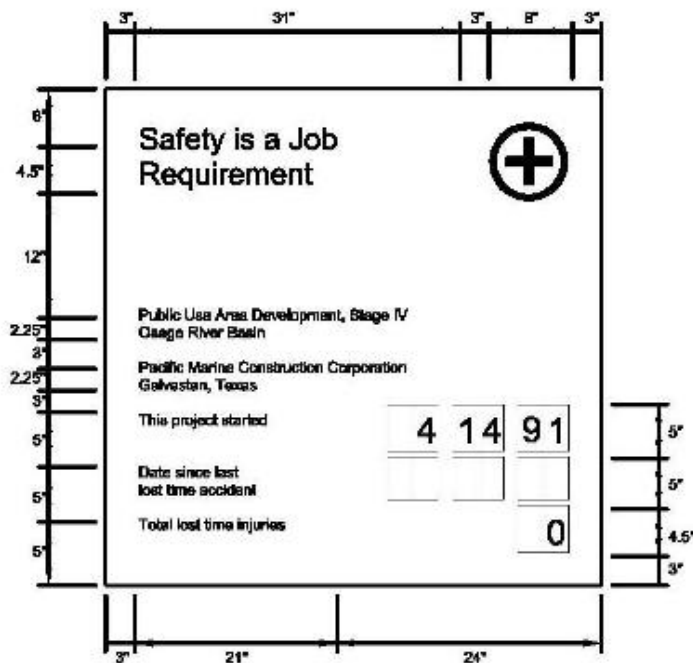
All typography is flush left and rag right, upper and lower case with initial capitals only as shown. Letter- and word-spacing to follow Corps standards as specified in Appendix D.



Sign Type	Legend Size (A)	Panel Size	Post Size	Specification Code	Mounting Height	Color Bkg/Lgd
CID-01	various	4'x6'	4"x4"	HDO-3	48"	WH-RD/BK

FIGURE 2

SAFETY SIGN



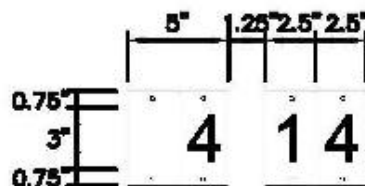
All typography is flush left and rag right, upper and lower case with initial capitals only as shown. Letter and word spacing to follow Corps Standards (EP 310-1-6a and 6b).

Legend Group 1: Standard two-line title "Safety is a Job Requirement" with (8" od.) Safety Green First Aid logo. Typeface: 3" Helvetica Bold; Color: Black.

Legend Group 2: One to two-line project title legend describes the work being done under this contract and name of host project. Typeface: 1.5" Helvetica Regular; Color: Black; Maximum line length: 42".

Legend Group 3: One to two-line identification: name of prime contractor and city, state address. Typeface: 1.5" Helvetica Regular; Color: Black; Maximum line length: 42".

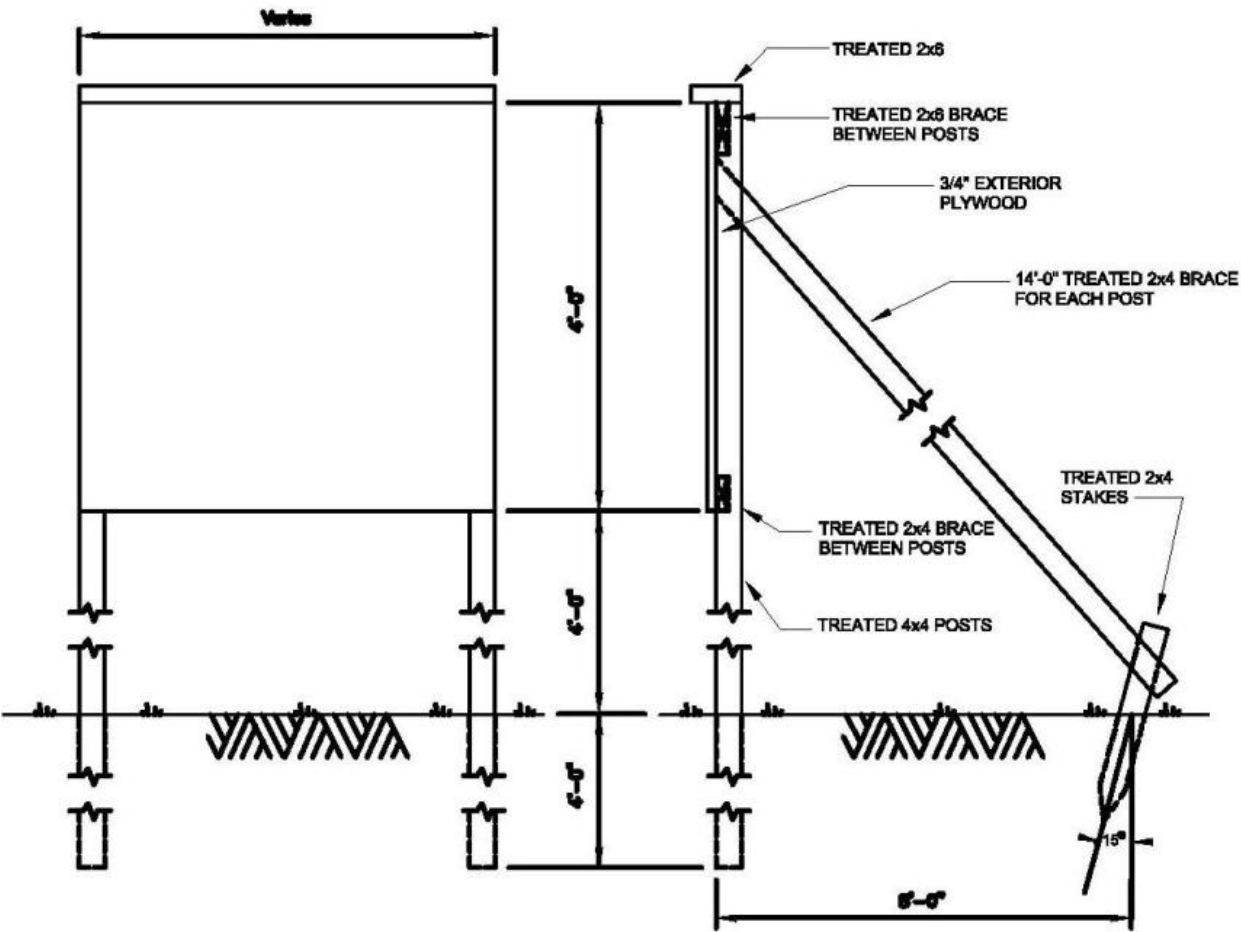
Legend Group 4: Standard safety record captions as shown. Typeface: 1.25" Helvetica Regular; Color: Black.



Replaceable numbers are to be mounted on white 0.060 aluminum plates and screw-mounted to backdrop. Typeface: 3" Helvetica Regular; Color: Black; Plate size: 2.5"x 4.5".

FIGURE 3

SIGN ERECTION DETAILS



6.Signs

6.0

General Notes

GW TH TT TP SS OS FA FH CS

(Page 1 of 2)

Current Policy

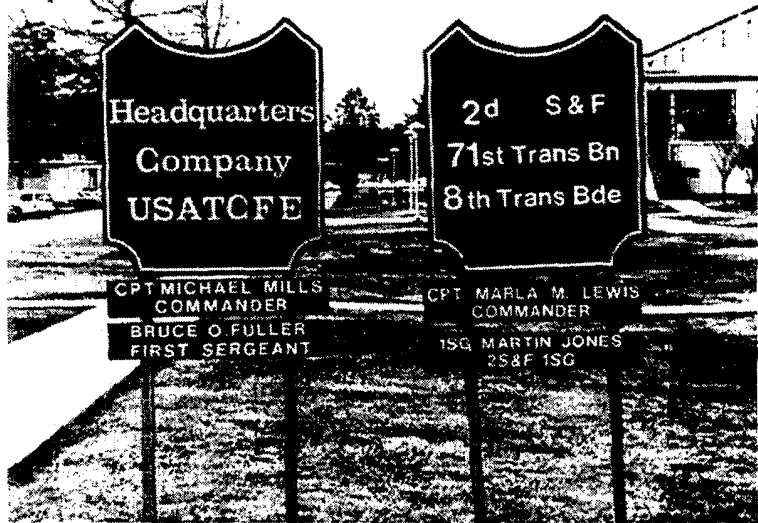
Presently, several different sign types are used with varying degrees of success. A standard "colonial" shaped signboard has been used for many signs and has been effective in projecting a distinctive institutional image for the post. However, the single size of that format has been somewhat limiting when numerous messages must be presented. This has, in some areas, required several signs to be installed close together, causing the appearance of clutter and redundancy.

Information arrangement on each signboard is frequently illegible or unintelligible. This occurs when too much information is presented, too many unnecessary words or titles are shown, and the titles are presented without a meaningful arrangement to distinguish between different entities being identified. Often, all upper case letters are used and are difficult to read. Typeface styles are mixed and used inconsistently.

The Design Criteria

The goal of these design criteria is the establishment of a hierarchy of information and sign type which presents information clearly, projects a unified image, and is flexible and adaptable to accommodate a wide range of message requirements. The pages that follow describe a coordinated "menu" of signboard types and sizes, which will allow for the "colonial" shape used for specific identification purposes, while rectangular shapes will be used for all directional and directory information.

Signage throughout the installation must be skillfully managed and coordinated according to an overall Signage Master Plan, prepared and maintained by the DEH. (See TM5-807-10 "Signage" for further guidance on developing this master plan.)



Two "colonial" signs placed side by side appear redundant and demonstrate an inadequacy in the signage system.

Even with the most extensive design controls, however, any signage policy must be skillfully adapted to each situation. Although the appearance of consistency and standardization is important, this effect can only be achieved by carefully adapting signage design criteria to particular circumstances. Rigidly applied controls frequently result in specific solutions that are uniform, but appear to be inappropriate.

Most importantly, the information itself must be carefully condensed and organized on the signs in an efficient hierarchical fashion. The spatial arrangement of the information on each sign is itself part of the message, and is as important as the specific wording.

☐ AR

☐ LA

☐ CE

☐ ME

☐ EE

☐ MT

6.Signs

6.0

General Notes

GW TH TT TP SS OS FA FH CS

(Page 2 of 2)

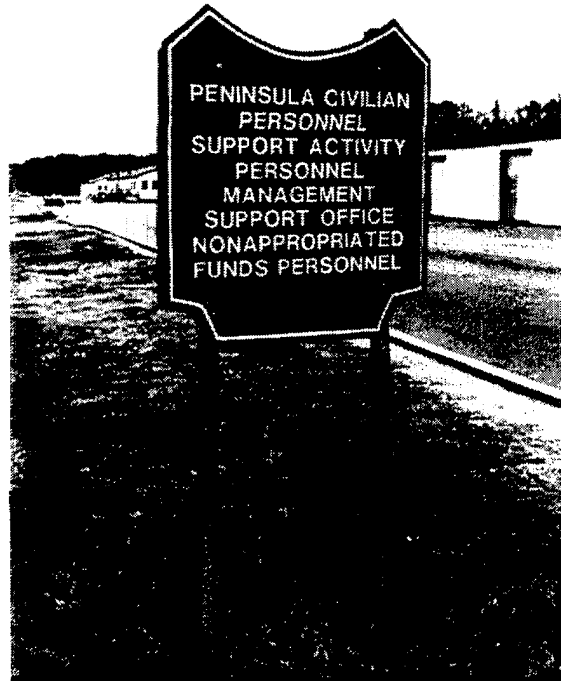
Army-Wide Sign Policy

TM5-807-10 "Signage" must continue to serve as the primary source for guidance on message content, typography, and organized arrangement of the information on the signboard. The design criteria included here provide guidance on the size and shape of the signboard, materials, and fabrication of the supports, and special considerations related to the "colonial" sign shape.

Summary of Recommendations

The following sign policy improvements have been incorporated into these design criteria:

- The specific shape of the "colonial" signboard is refined to a recognizable pediment profile.
- Typeface styles and letter sizes are specified for consistency.
- Arrangement of information on signs is prescribed according to message function.
- Upper and lower case letters are to be used for all situations. This makes messages more easily legible than when all upper case is used.
- The design of the monumental masonry sign is refined. This should be applied to all future monumental signs.
- The support posts for all other signs are to be 4 x 4 treated wood rather than the metal perforated posts currently in use. This is to give each sign the appearance of permanence and substance representative of the importance of the installation.



Too many words result in an unintelligible sign.

☐ AR

☐ LA

☐ CE

☐ ME

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Sign Types and Dimensions

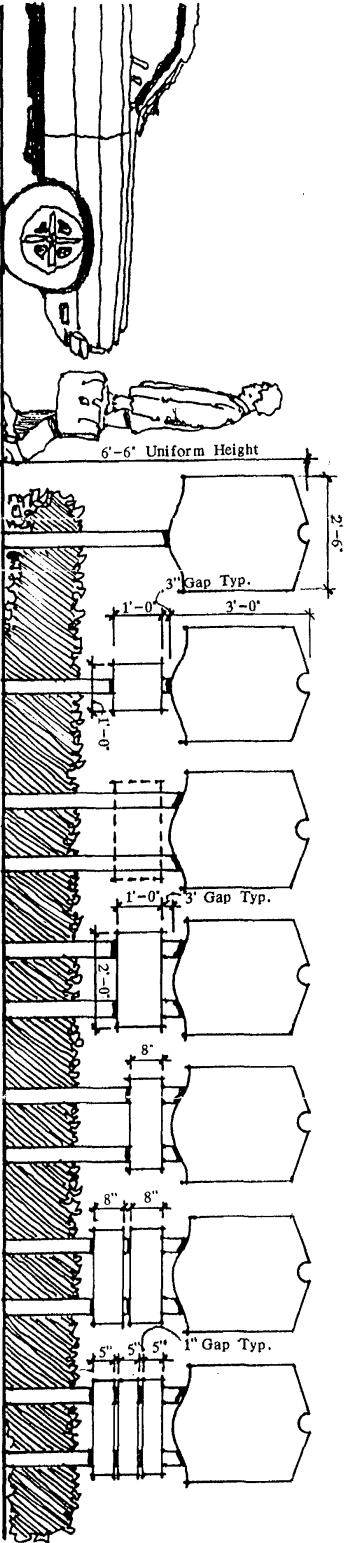
Recommendations for selecting sign types and panel sizes:

The illustrations demonstrate most choices and combinations necessary to accommodate any message requirement. Whenever possible, limit choices to those included on these pages so that signage throughout the post will be coordinated.

Certain sign sizes and shapes must be visually associated with specific categories of information. Message types must, therefore, be restricted to a limited set of sign size/shape options. Refer to the chart on page 6.1 for permitted sign type choices for your message type.

Type A signs are to be used primarily for identification signs at the location of the facility identified. No directional arrows are permitted on these signs. Secondary signboards may be used beneath the "colonial" board to carry directional and directory type information. Type A signs are to be used sparingly. Do not locate within 100 ft. of one another.

Type B are to be used in lieu of a type A sign whenever the smaller format can adequately satisfy the message requirement. Use type B8 for identification of minor facilities to avoid overuse of the type A signs. Type B signs are to be generally associated with directional, directory, informational, mandatory and motivational messages.

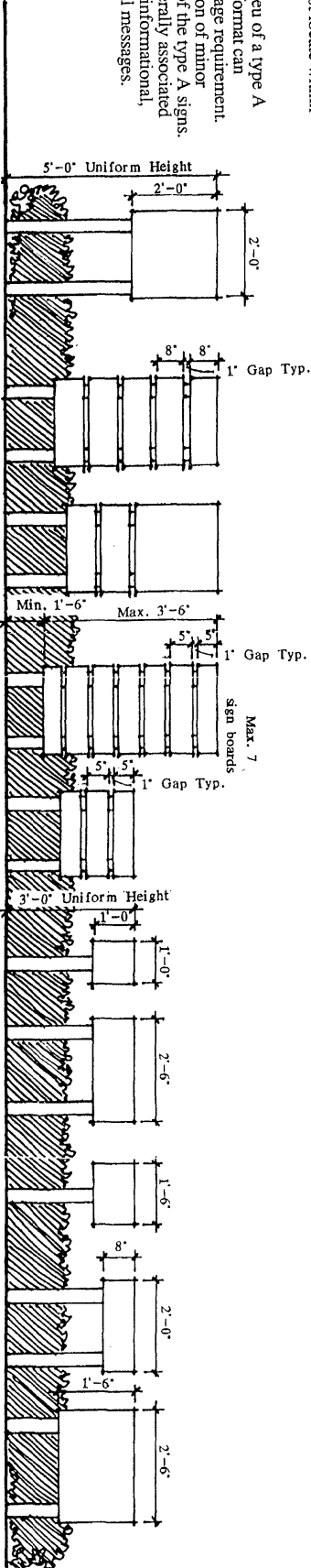


Type A Signs

Single Supports

Double Supports

- A1. Shield Only.
- A2. Shield plus small secondary sign.
- A3. Shield with allowance for future secondary sign.
- A4. Shield with 12" secondary sign.
- A5.
- A6.
- A7.



Type B Signs

- B1. Single large panel.
- B2. Series of medium size panels for changeable messages.
- B3. Combination.
- B4. Directory or directional series, 4 to 7 panels.
- B5. Directory or directional, 3 panels.
- B6. Small single square panel.
- B7. Medium size panel.
- B8. Medium size panel.
- B9. Medium size panel.
- B10. Large single panel.

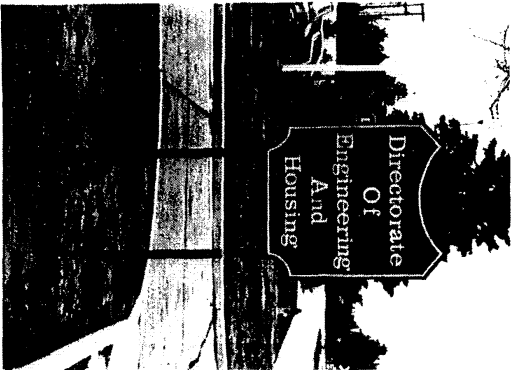
6. Signs

Sign Types and Dimensions

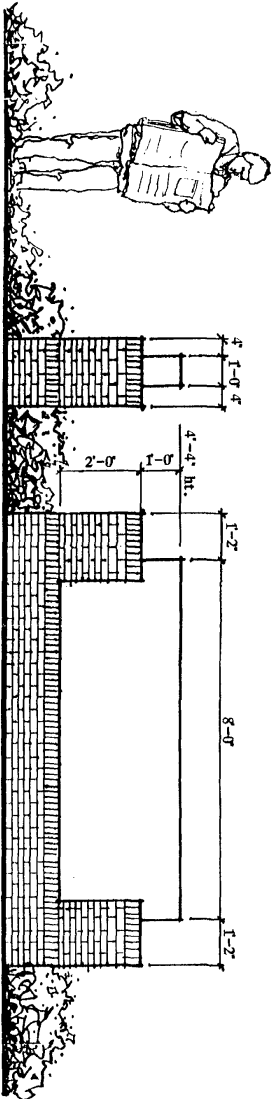
Type C (monumental signs) are to be used for major identification signs or for post identification signs at the major roadway(s) entering the installation. Sign type C2 should be limited to post identification use. It is recommended for the proposed new post entrance road or for replacement of the existing post identification sign, should that become necessary.

Type C2 may be used for identifying important buildings or complexes, such as "Third Port," "Bunker Training Area," "Felter Army Airfield," etc.

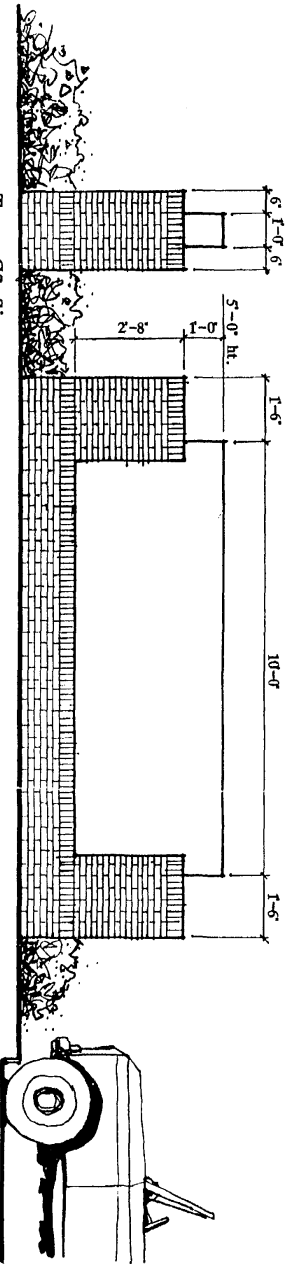
Type C signs are to be used sparingly. They are very special signs which must command attention. Do not place two type C signs within 500 ft. (min.) of each other.



A good example.



Type C1 Sign
For identification of major buildings or complexes.



Type C2 Sign
For post identification at major entrance(s) to the Installation.

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6.Signs

6.1

Mounting Heights

Sign heights must be consistent. Use a uniform 6'6" ht. and dimension to top of signboard for all type A signs. Use 5'0" or 3'0" ht. for types B1 through B10. Refer to preceeding pages for complete mounting height information.

In general, the size and height should be minimized, wherever possible, to reduce visual clutter.

Choose a sign sized as small as possible which will adequately do the job. Choose the 3'0" mounting height for type B signs whenever this will satisfy the message requirements.

Important!

Organize the information on the sign to be brief, clear, and concise.

Note:

Identification signs are those that state the name of the building or facility at that location. *Directional signs* point the way to a destination with an arrow. *Directory signs* are those that list a series of destinations within a building or in an area of the post, and may serve as secondary information to an identification sign. *Informational signs* convey other general messages such as schedules, policies or regulations. *Mandatory signs* carry imperative regulatory messages such as warnings and restrictions. *Motivational signs* are those that carry inspirational slogans to support training and morale.

GW TH TT TP SS OS FA FH CS

(Page 3 of 3)

Key:

● Permitted

▲ Not Permitted

○ Message Permitted on Secondary Sign Board Only

Type of Sign (D.C.6.1):	Type of Message Required					
	Identification	Directional	Directory	Informational	Mandatory/Prohibitory	Motivational
A1 Shields	●	▲	▲	▲	▲	▲
A2	●	○	▲	○	▲	▲
A3	●	▲	▲	▲	▲	▲
A4	●	○	○	○	▲	▲
A5	●	○	○	○	▲	▲
A6	●	○	○	▲	▲	▲
A7	●	○	○	▲	▲	▲
B1 Rectangular	▲	▲	▲	●	●	●
B2	▲	▲	●	▲	▲	▲
B3	▲	▲	○	●	▲	○
B4	▲	●	●	▲	▲	▲
B5	▲	●	●	▲	▲	▲
B6	▲	▲	▲	●	●	●
B7	▲	▲	●	●	●	●
B8	●	▲	▲	●	●	●
B9	▲	▲	●	●	▲	●
B10	▲	▲	▲	●	●	●
C1 Monumental	●	▲	▲	▲	▲	▲
C2	●	▲	▲	▲	▲	▲

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□ ME

□ EE

□ MT

6.2.1

GW TH TT TP SS OS FA FH CS

Technical drawing showing the side and end elevations of a roof structure with a 45-degree pitch.

Side Elevation Dimensions:

- Overall width: 2'-6"
- Horizontal divisions: eq. (equal)
- Vertical dimensions: 3'-0", 1'-0", 2'-3"
- Roof pitch: 45 degrees
- Labels: 1" Typ, 3" Gap Typ.
- Overall height: 6'-6" Uniform Height

End Elevation:

- Shows the cross-section of the roof structure.
- Label: 45 degrees

Where additional directory or directional — information is necessary, do not clutter the "shield", but use a single square sign below (max. 12" square).

Plant post firmly in ground minimum 3' deep (or deeper where high winds and sandy soil require).

Note:

As an option, 4" x 4" metal posts may be used in lieu of pressure-treated wood.

Note:

1/2" exterior grade plywood may be considered as an alternative signboard material. Paint all surfaces.

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6.Signs

6.2.2

Materials and Fabrication Type A; Double Support

GW TH TT TP SS OS FA FH CS

Signboard to be 10 or 12 gauge painted, galvanized sheet metal. Fasten to wood cross piece at four corner points with round-headed galvanized #5, 1 1/2" wood screws.

Posts to be 4 x 4 pressure-treated wood (treated with pentachlorophenol). Cut top at 45° angle.

Cross pieces to be 2 x 4 pressure-treated wood. Fasten to vertical post using mortise joint and two galvanized hex. head 3" lag bolts.

Where additional directory or directional information is necessary, do not clutter the "shield", but use secondary signboards (see DC 6.1 for choices available).

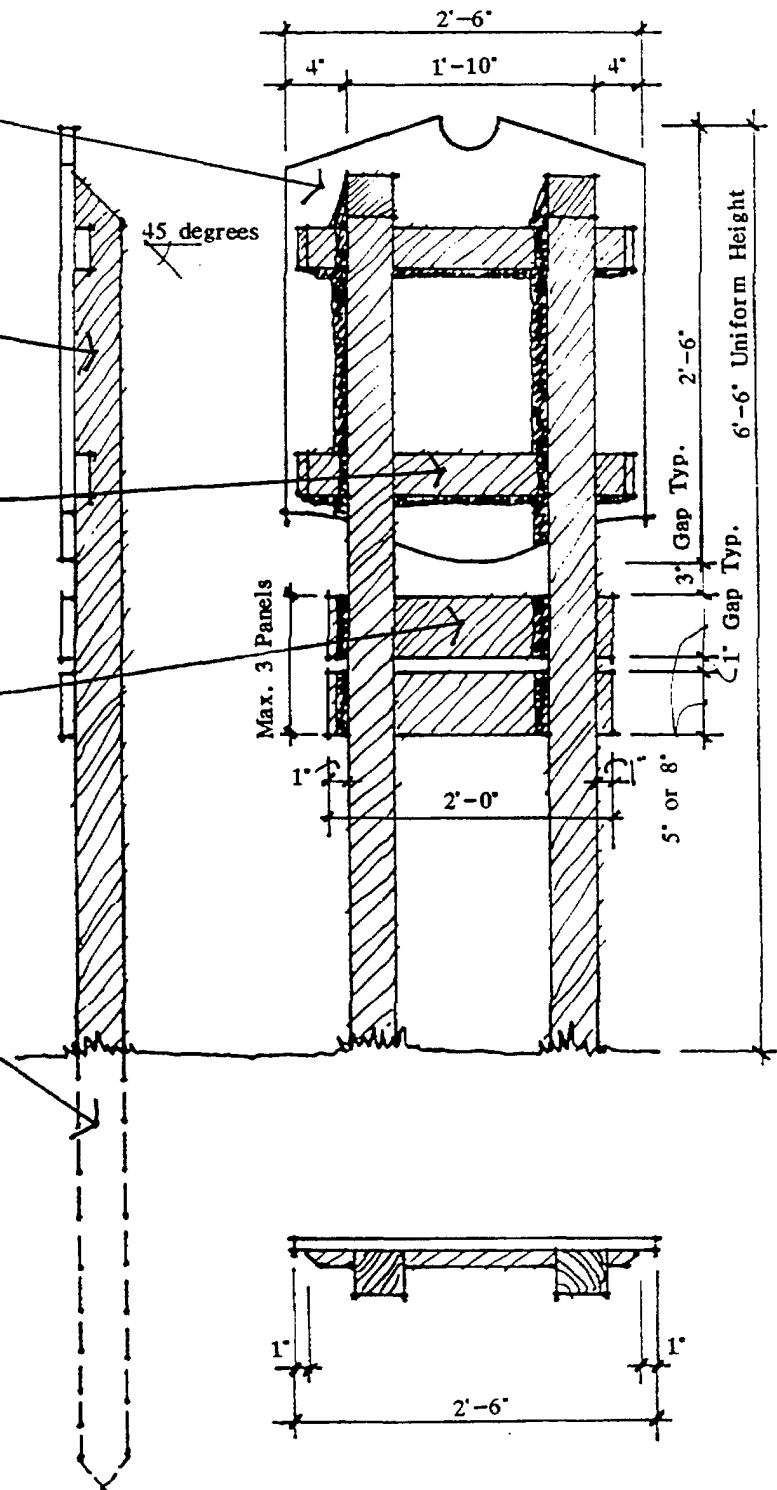
Plant post firmly in ground--minimum 3' deep (or deeper where high winds and sandy soil require).

Note:

As an option, 4" x 4" metal posts may be used in lieu of pressure-treated wood.

Note:

1/2" exterior grade plywood may be considered as an alternative signboard material. Paint all surfaces.



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6.Signs

6.2.3

Materials and Fabrication Type B

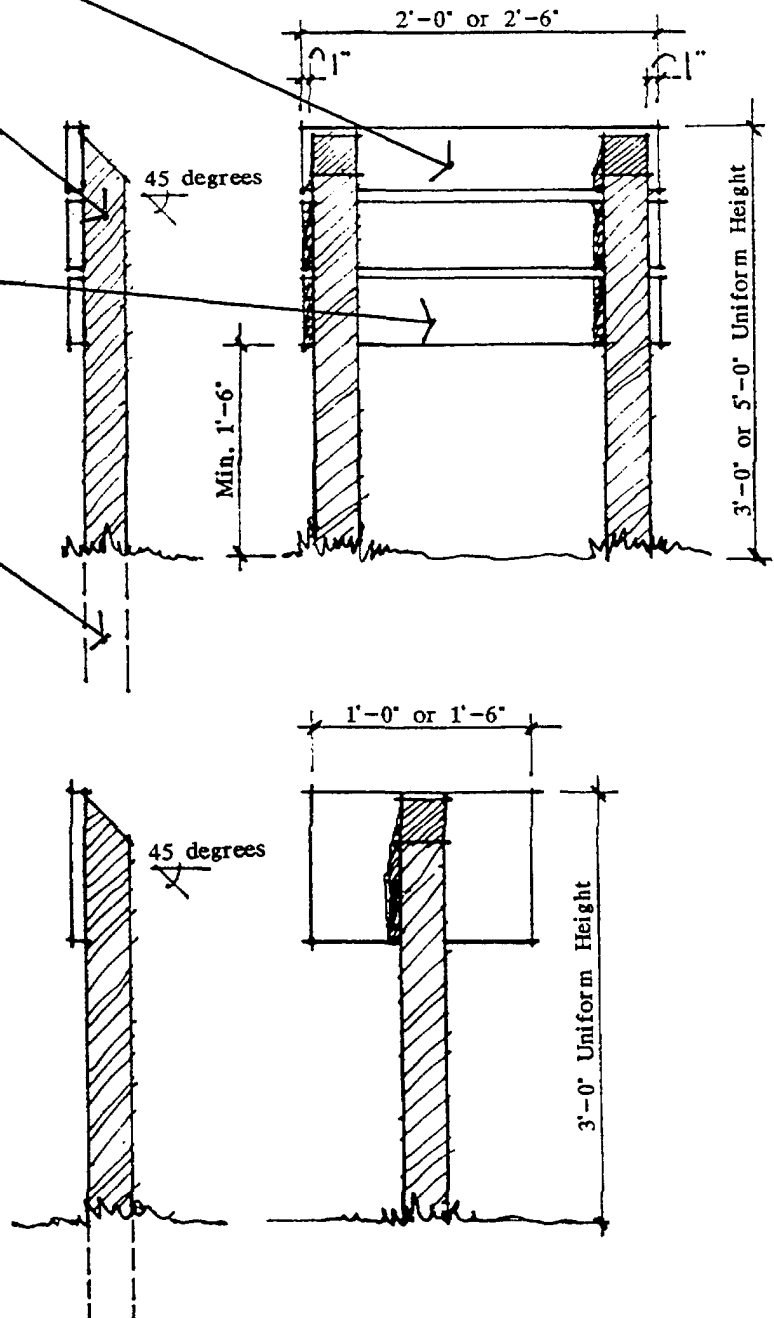
GW TH TT TP SS OS FA FH CS

Signboard to be 10 or 12 gauge painted, galvanized sheet metal. Fasten to vertical posts using two round-headed galvanized #5, 1 1/2" wood screws at each end of sign.

Posts to be 4 x 4 pressure-treated wood (treated with pentachlorophenol). Cut top at 45° angle. Posts must be absolutely straight, plumb and aligned with each other.

Use up to three individual 5" signboards for directory/directional messages on 3'0" standard height. Where required use up to seven individual 5" signboards on 5'0" standard height. See DC 6.1 for other combinations and choices.

Plant post firmly in ground, minimum 3' deep (or deeper where high winds and sandy soil require).



Note:

As an option, 4" x 4" metal posts may be used in lieu of pressure-treated wood.

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6.Signs

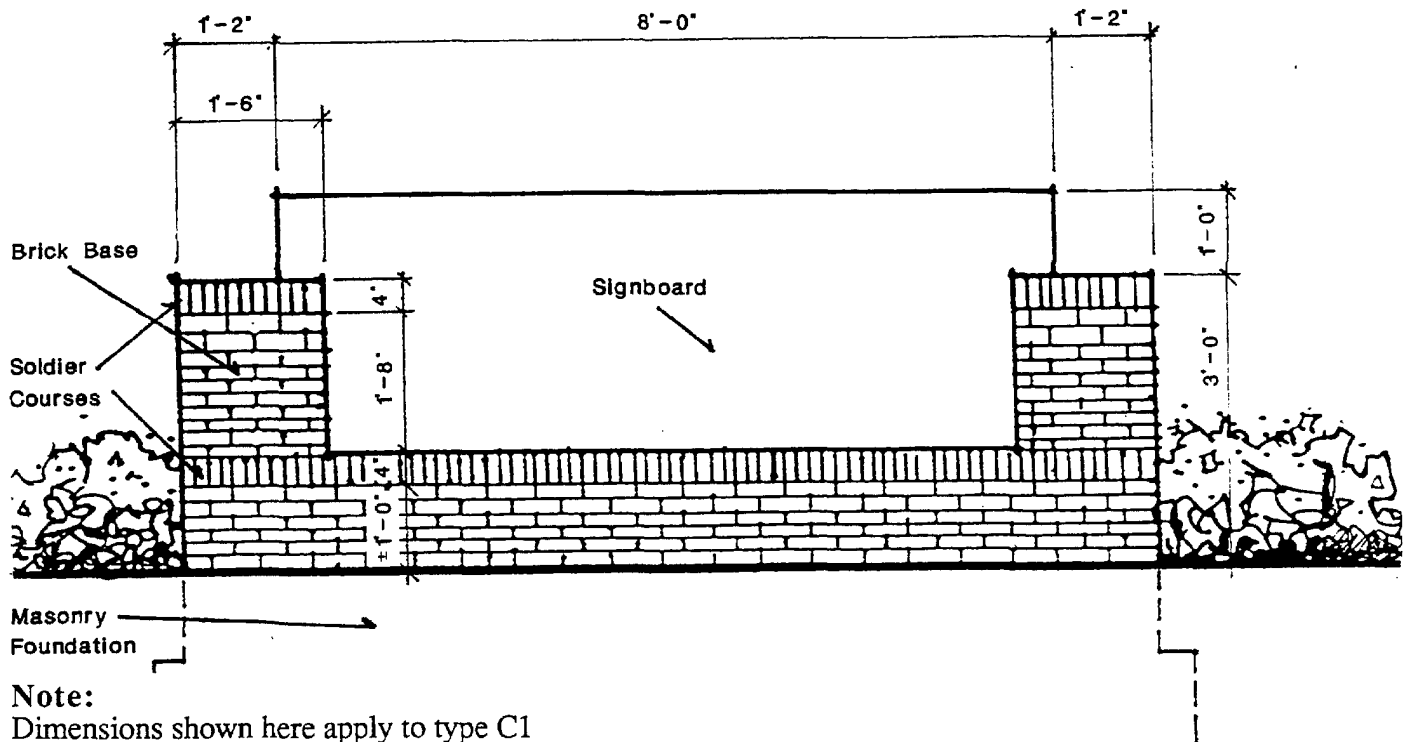
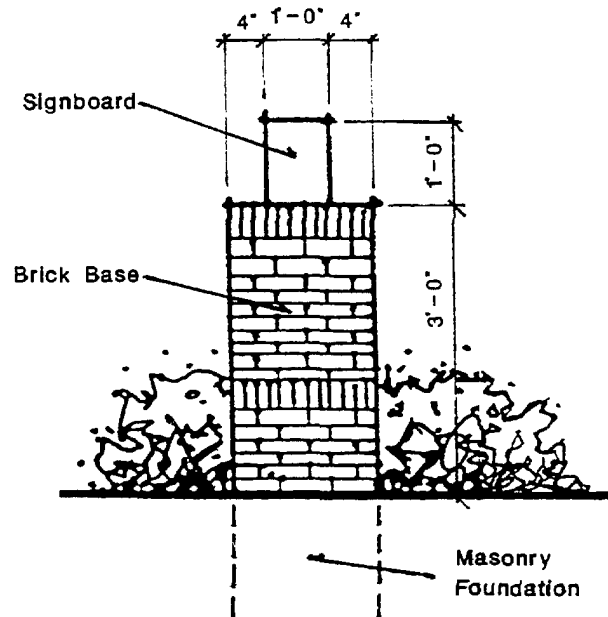
6.2.4

Materials and Fabrication Type C; Monumental

Signboard to be aluminum sheet metal (0.125), built as a box with internal framing/bracing as required for strength. Top, sides, and edges are to be weather-proof with weep holes provided at the bottom for release of condensation moisture. Finish to baked enamel type paint (See DC 6.4.2).

Raised Lettering to be pinned onto aluminum or baked acrylic signboard and to be of cast or sheet aluminum (0.25" min.). Face of letter is to stand uniformly 1" in front of face of signboard. 1" deep cast letters are recommended. All pin connectors, spacers, etc. are to be of aluminum to avoid galvanic corrosion.

Base to be built securely on a masonry/reinforced concrete foundation as required for local soil conditions. Face brick to be of standard brick dimensions (no jumbo brick or concrete block to be used).



Note:

Dimensions shown here apply to type C1 sign. See DC 6.1, page 2 for type C2 sign dimensions.

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6.Signs

6.3

Typography Typeface Style

GW TH TT TP SS OS FA FH CS

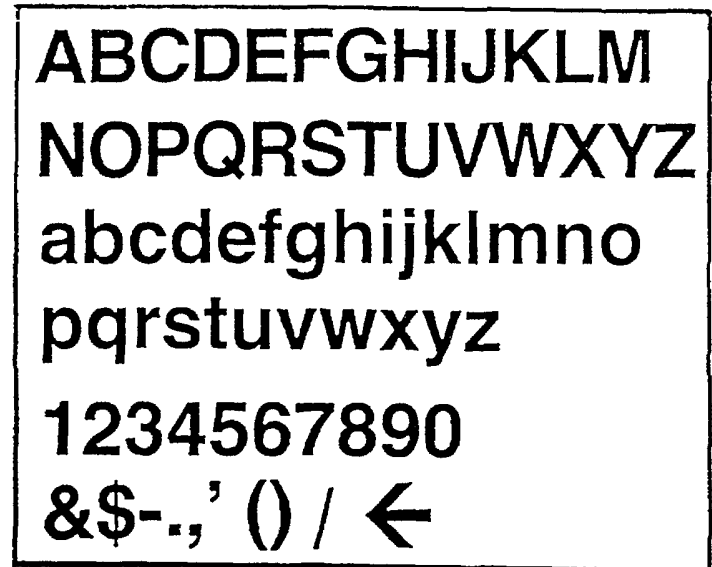
(Page 1 of 2)

Three typefaces are to be used on the Post signs: helvetica medium, helvetica regular, and claredon. Where and when each of these typeface styles is permitted to be used depends upon the message function and the type of signboard used.

Traffic control signs are exempted (they should follow Standard Alphabets for Highway Signs and Pavement Mark lines, published by Federal Highway Administration).

Helvetica medium is to be used on all type B signs. Use upper and lower case letters.

Helvetica regular may be used in special cases on type B signs when primary and secondary information must be distinguished to clarify the message. In this case, use **helvetica medium** for primary information and **helvetica regular** for secondary information



Helvetica Medium



Helvetica Regular

Additional Reference

Refer also to TM5-807-10 "Signage" for additional guidance.

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6.Signs

6.3

Typography

GW TH TT TP SS OS FA FH CS

(Page 2 of 2)

Claredon is to be used for major information on all type A and C signs such as the primary name of a building, or general name of an area such as "Command Center". Only claredon is permitted on type C (monumental) signs. Use claredon for all messages on type C signs. Use upper and lower case letters.

**ABCDEFGHIJKLMN
OPQRSTUVWXYZ
&abcdefghijklmnopqrstuvwxyz
ijklmnopqrstuvwxyz
fifl12345678
90\$.,"-:;!?"'“**

Clarendon

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Friday, July 23, 2010

6.Signs

6.4.1

Colors

GW TH TT TP SS OS FA FH CS

Types A and B Signs

Paint both front and back face of signboard in dark brown (match Sherwin-Williams Ex BM2-8).

Paint 3/8" wide border in reflective white.

Unit insignia in standard colors of emblem. Outline in white to distinguish from dark brown background.

Lettering to be reflective white adhesive-backed vinyl die-cut type, reflective to auto headlights at night. (See p. 2-2, TM5-807-10 for additional guidance.)

Supports to be unfinished pressure-treated wood, stained with a dark brown opaque wood preservative, if desired.

Secondary sign colors to match primary signs.

Public Affairs
TRADOC
Provost Marshall
Administration
Control Center

642

COL. W.B. Marshalton
Dir. Public Affairs

LTC. P. J. Batchelor
Provost Marshall

Note (regulatory signs):

Red band on regulatory signs are to match PMS#032C or, if painted, match Sherwin-Williams BM1-7. Exclaimer word on red band to be white letters reflective at night.

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6.Signs

6.4.2

Colors

GW TH TT TP SS OS FA FH CS

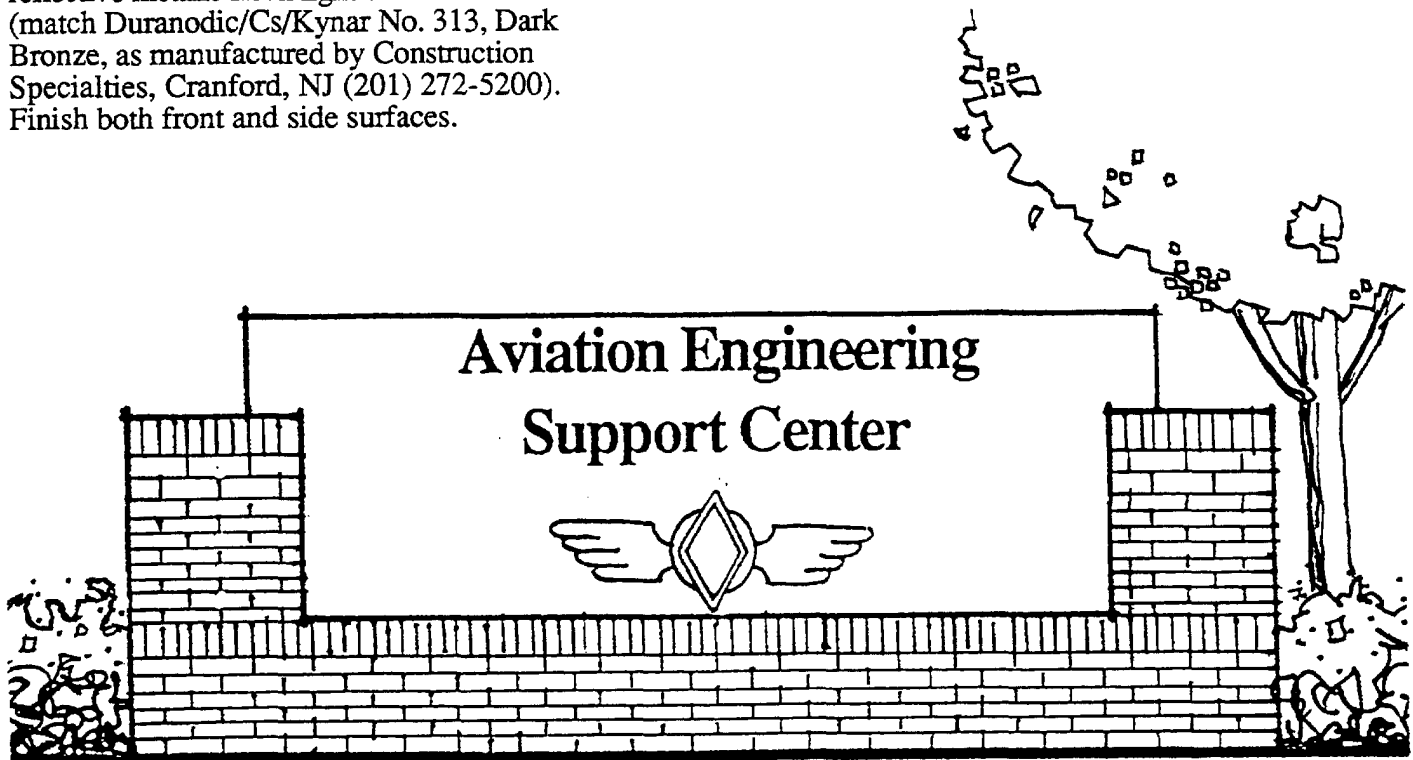
Type C; Monumental

Brick to match color of the post Headquarters Building. Standard brick unit dimensions (not jumbo brick) to be used.

Mortar to be tinted slightly to a reddish tan color (match Medusa Stoneset-Natural Sand).

Signboard to be finished in a warm medium grey color with a matt/dull finish to avoid reflective glare (match CS/Kynar No. 48, New Light Bronze, as manufactured by Construction Specialties, Cranford, NJ (201) 272-5200).

Raised metal lettering to be finished in a reflective metallic fleck light bronze color (match Duranodic/Cs/Kynar No. 313, Dark Bronze, as manufactured by Construction Specialties, Cranford, NJ (201) 272-5200). Finish both front and side surfaces.



See DC 6.3 for specific typeface requirements.
(Claredon)

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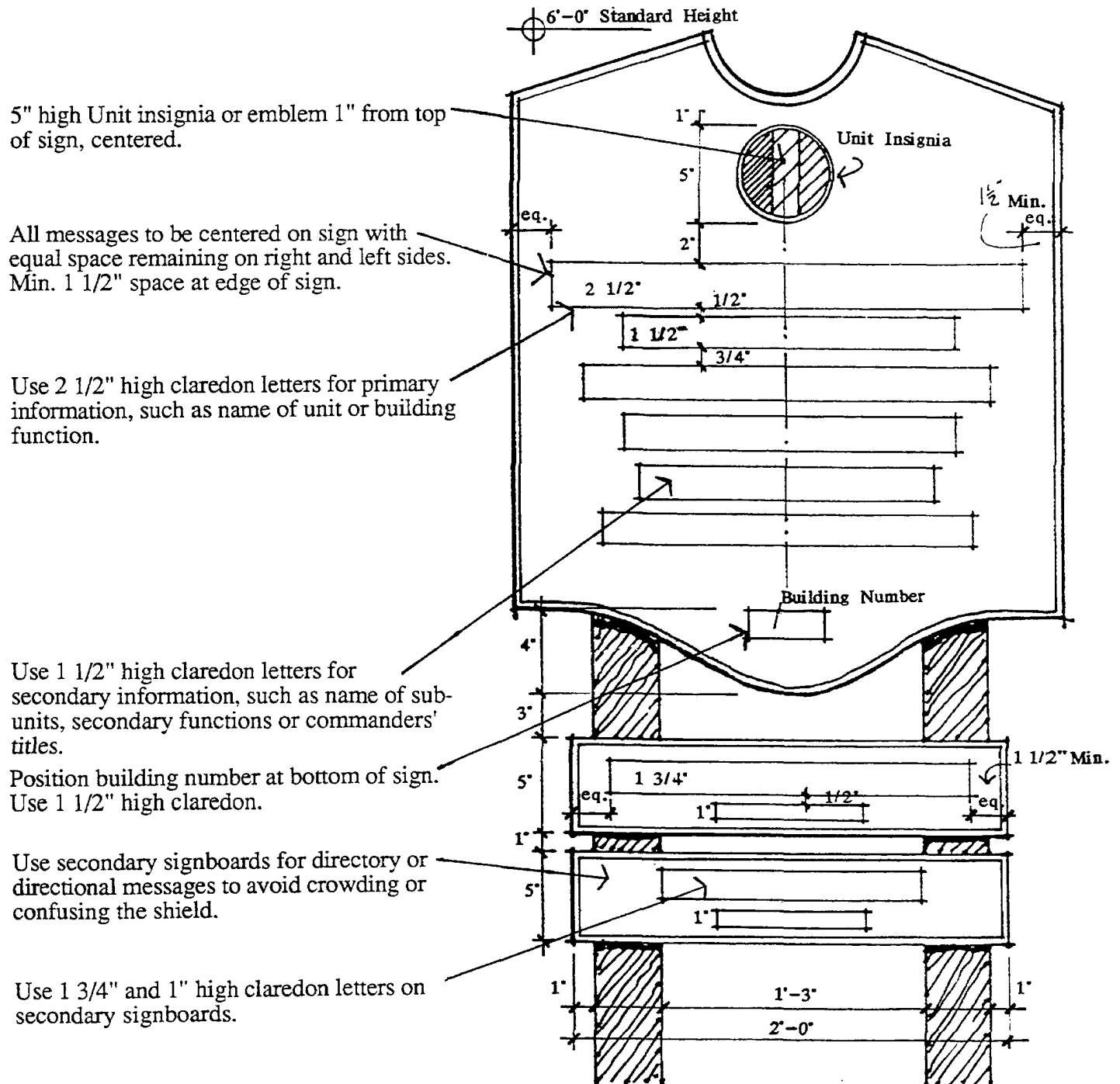
☐ MT

6.Signs

6.5.1

Sign Layout Type A; Shield

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See DC 6.4 for sample message layout.

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6.Signs

6.5.2

Sign Layout Type B; Directional/Directory

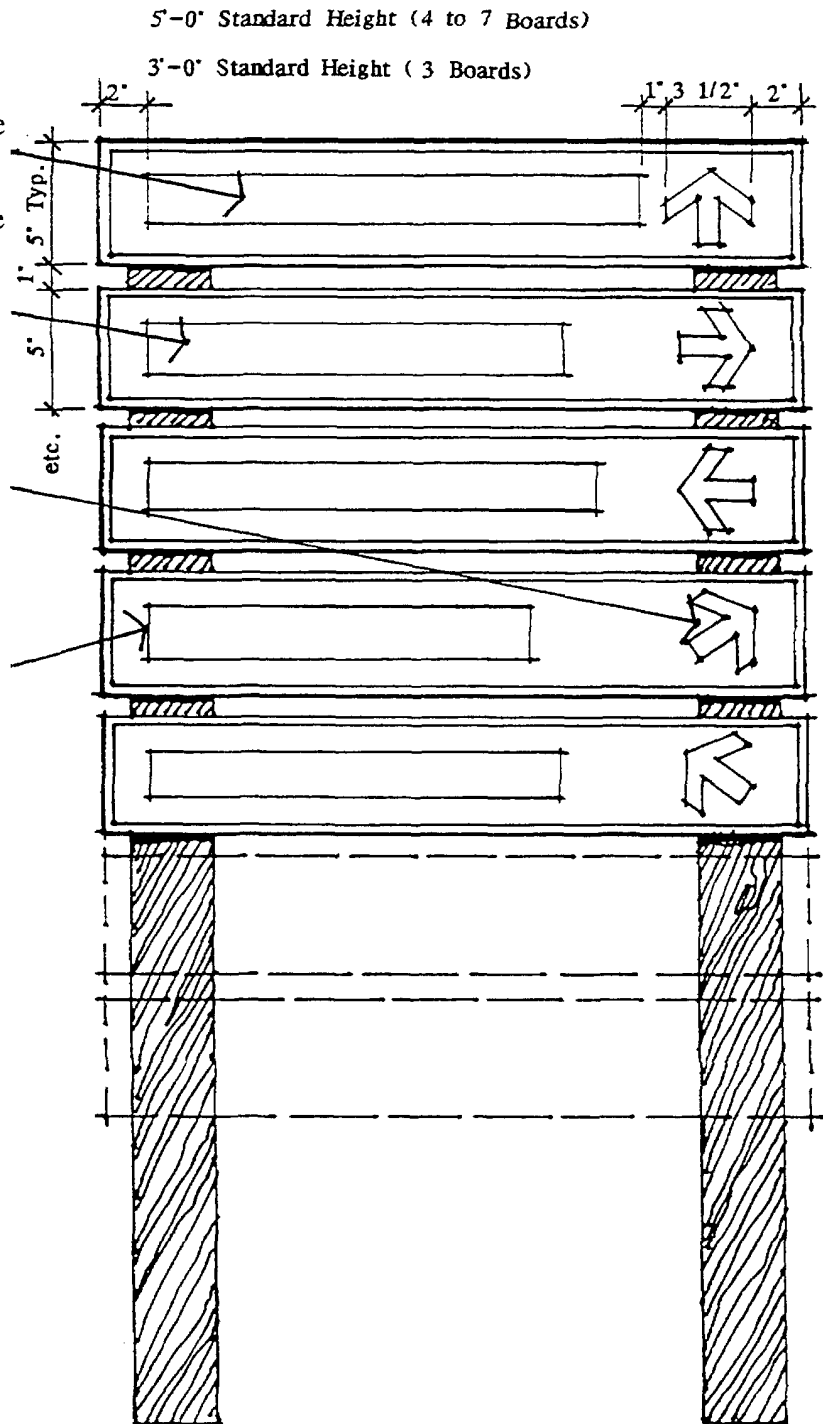
GW TH TT TP SS OS FA FH CS

Use helvetica medium, upper and lower case letters for all destinations.

Identify, in brief terms, the destination. Use 2 1/2" high upper and lower case letters, maximum 1'4" long in total (approximately twenty characters).

Use 4" high/wide arrows, positioned consistently at right side of sign. (See page 2-5, TM5-807-10 "Signage" for exact shape of arrow.)

Lettering on each sign is to be positioned "flush left," beginning consistently 2" from left edge of sign.



Important Note:

Keep messages brief. Directional messages must be read and understood quickly.

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6.Signs

6.5.3

Sign Layout

Type B; Regulatory/Informational

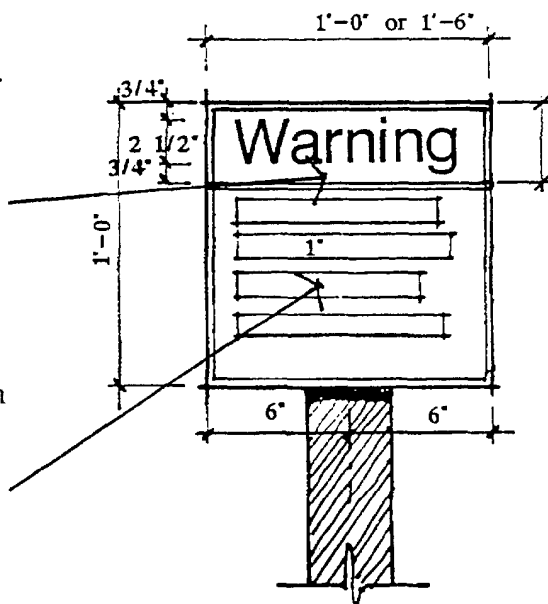
GW TH TT TP SS OS FA FH CS

Mandatory information, regulations, prohibitions and warning messages must be distinguished from other sign types by use of separate signboards with an accent stripe.

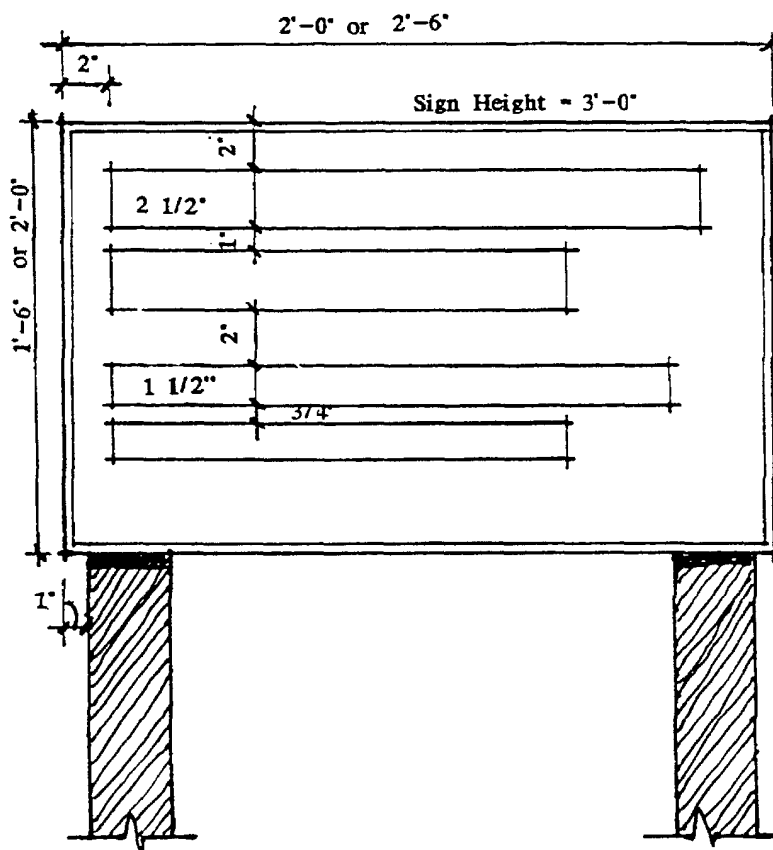
Use a red 4" high horizontal band at the top of the sign (see DC 6.4 for color spec.).

Use an exclamer word, such as "Attention," "Caution" or "Warning" in 2 1/2" high white reflective helvetica medium letters centered on the red band (see DC 6.4).

Position the message below the stripe in 1" high letters, flush left 1 1/2" from edge of sign.



General information on medium-sized signboards to be presented in 1" to 2 1/2" high letters beginning flush left 2" from edge of sign. Primary information in 2 1/2" letters, secondary information in 1" or 1 1/2" letters. Use only two different letter sizes per sign.



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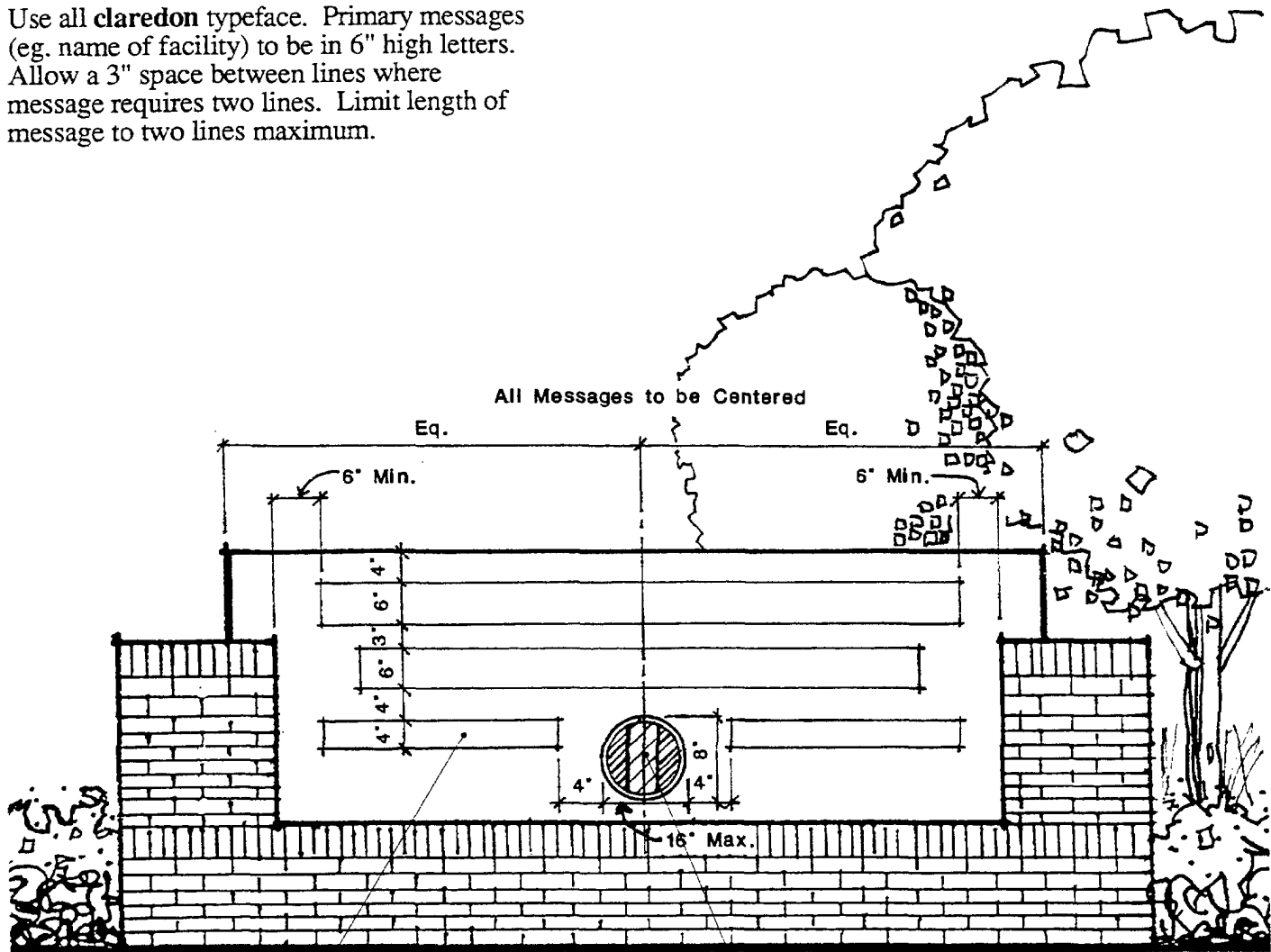
6.Signs

6.5.4

Sign Layout Type C; Monumental

All messages to be centered on sign with equal space remaining on the right and left sides. Minimum 6" space must be allowed at sides.

Use all **claredon** typeface. Primary messages (eg. name of facility) to be in 6" high letters. Allow a 3" space between lines where message requires two lines. Limit length of message to two lines maximum.



Secondary information is to be minimized or omitted. When necessary, it is to be placed at the bottom of the sign, 4" below the primary message.

Unit emblems and insignia may be placed center below message. 8" h. x 16" w. max. size.



REQUEST FOR PROPOSAL



APPENDIX-I

ACCEPTABLE PLANT LIST

3.Landscape

3.6

Introduction

GW TH TT TP SS OS FA FH CS

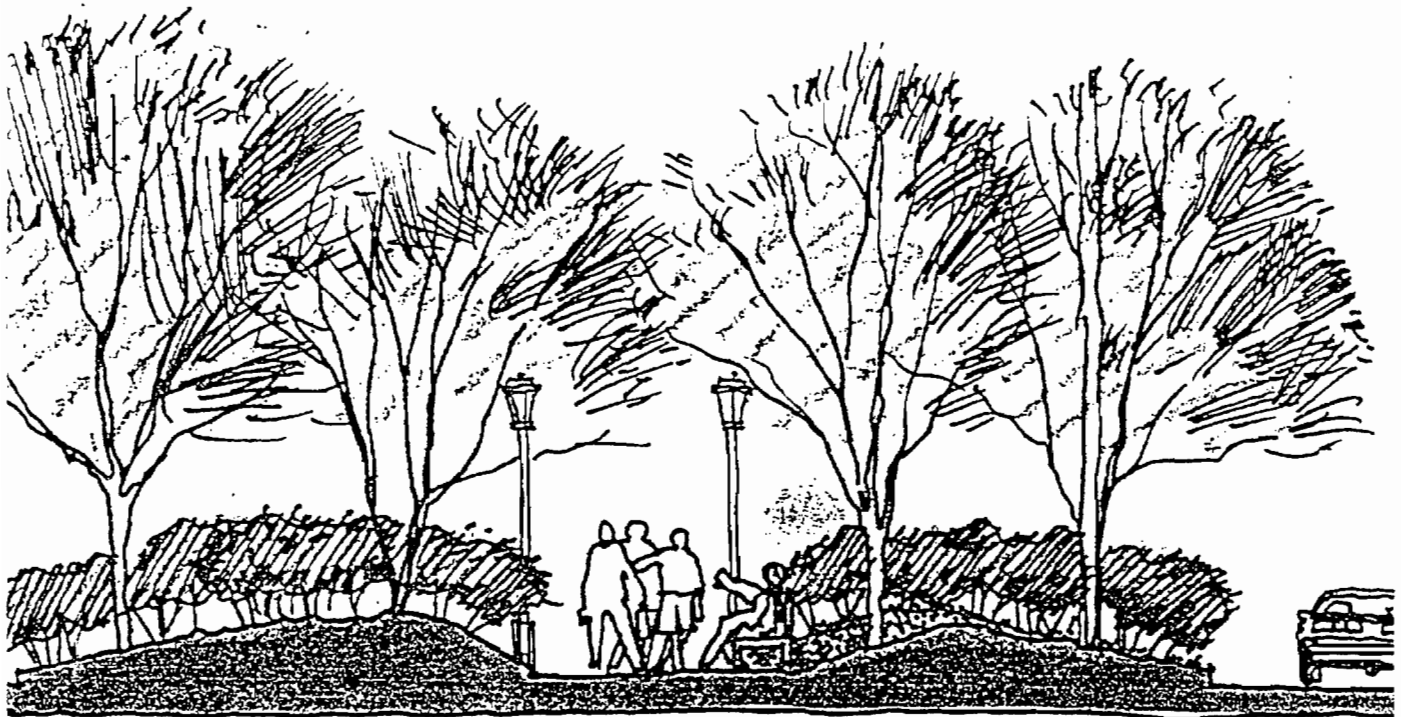
How to Use the Plant Matrix

The following PLANT MATRIX should be used in conjunction with a thorough investigation of the micro-climate of the specific planting project. This plant matrix should then be used as a guideline to developing a plant list for the specific project subject to review by the post horticulturalist. These are recommended species and do not necessarily preclude the selection of other species based on availability and cost or other factors.

The plant matrix is organized into plant categories of Trees (deciduous), Evergreen Trees, Ornamental Trees, Shrubs and Ground Covers. The applicable criteria checklist to the right of the species will tell the user the following information:

- Type (Indigenous, Deciduous, Evergreen)
- Visual Zone (appropriate application)
- Application (how the plant can be used)
- Exposure (degree of sun, shade)
- Soil (tolerable plant medium)

The post horticulturalist or design professional may use this list as an initial guide, and apply other design criteria for selection and location on a planting plan.



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3.Landscape

3.6

Plant Matrix

GW TH TT TP SS OS FA FH CS

1 of 7

Botanical Name
Common Name

TREES

Acer ginnala
Amur Maple

Acer palmatum
Japanese Maple

Acer platanoides
Norway Maple

Acer rubrum
Red Maple

Carpinus caroliniana
American Hornbeam

Celtis occidentalis
Hackberry

Cercidiphyllum japonicum
Katsura Tree

Fagus grandifolia
American Beech

Fraxinus pennsylvanica
Green Ash

Gleditsia triacanthos
Honey Locust

Liquidambar styraciflua
Sweetgum

Nyssa sylvatica
Sour Gum

Type	Visual Zone											Appl.		Exp.	Soil								
Deciduous	Evergreen	Indigenous	GW	TH	TT	TP	SS	OS	FA	FH	CS	Shade	Street Tree	Ornamental Interest	Screen	Erosion Control	Sun	Partial Shade	Shade	Dry	Molst	Adaptable	Salt Tolerant
●										●	●			●			●	●				●	
●										●	●			●			●	●			●		
●				●	●	●	●		●	●	●	●	●				●					●	
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3.Landscape

3.6

Plant Matrix

GW TH TT TP SS OS FA FH CS

2 of 7

Botanical Name

Common Name

TREES (continued)

Platanus acerifolia
 London Planetree

Quercus acutissima
 Sawtooth Oak

Quercus borealis
 Northern Red Oak

Quercus coccinea
 Scarlet Oak

Quercus 'darlingtonia'
 Darlington Oak

Quercus palustris
 Pin Oak

Quercus phellos
 Willow Oak

Quercus virginiana
 Live Oak

Sophora japonica
 Japanese Scholartree

Taxodium distichum
 Bald Cypress

Tilia cordata
 Little leaf Linden

Zelkova serrata
 Japanese Zelkova

Type	Visual Zone										Appl.	Exp.	Soil										
Deciduous	Evergreen	Indigenous	GW	TH	TT	TP	SS	OS	FA	FH	CS	Shade	Street Tree	Ornamental Interest	Screen	Erosion Control	Sun	Partial Shade	Shade	Dry	Moist	Adaptable	Salt Tolerant
●			●	●						●	●	●	●	●			●				●	●	
				●	●	●	●			●	●	●					●					●	
		●	●	●	●	●	●	●	●	●	●	●	●				●	●		●			
		●	●	●	●	●	●	●	●	●	●	●	●				●						
	●			●						●	●			●			●				●	●	

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3.Landscape

3.6

Plant Matrix

GW TH TT TP SS OS FA FH CS

3 of 7

Botanical Name

Common Name

ORNAMENTAL TREES

Type	Visual Zone										Appl.		Exp.	Soil									
Deciduous	Evergreen	Indigenous	GW	TH	TT	TP	SS	OS	FA	FH	CS	Shade	Street Tree	Ornamental Interest	Screen	Erosion Control	Sun	Partial Shade	Shade	Dry	Moist	Adaptable	Salt Tolerant
●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
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3.Landscape

3.6

Plant Matrix

GW TH TT TP SS OS FA FH CS

4 of 7

Botanical Name

Common Name

ORNAMENTAL TREES (continued)

Prunus serrulata kwanzan
Kwanzan Cherry

Pyrus calleryana 'Bradford'
Bradford Pear

EVERGREEN TREES

Ilex opaca
American Holly

Juniperus virginiana
Eastern Redcedar

Picea abies
Norway Spruce

Pinus strobus
White Pine

Pinus taeda
Loblolly Pine

Pinus thunbergii
Japanese Black Pine

Type	Visual Zone										Appl.	Exp.	Soil										
Deciduous	Evergreen	Indigenous	GW	TH	TT	TP	SS	OS	FA	FH	CS	Shade	Street Tree	Ornamental Interest	Screen	Erosion Control	Sun	Partial Shade	Shade	Dry	Moist	Adaptable	Salt Tolerant
●				●	●	●				●	●			●			●				●		
													●	●			●					●	
		●	●	●	●	●	●	●	●	●	●												
	●		●	●	●			●		●	●			●	●		●	●	●	●			

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3.Landscape

3.6

Plant Matrix

GW TH TT TP SS OS FA FH CS

5 of 7

Botanical Name

Common Name

SHRUBS

Botanical Name	Type	Visual Zone										Appl.	Exp.	Soil										
Common Name	Deciduous	Evergreen	Indigenous	GW	TH	TT	TP	SS	OS	FA	FH	CS	Shade	Street Tree	Ornamental Interest	Screen	Erosion Control	Sun	Partial Shade	Shade	Dry	Moist	Adaptable	Salt Tolerant
SHRUBS																								
Abelia grandiflora Glossy Abelia		●		●	●	●					●	●			●		●	●	●	●			●	
Azalea species Azalea	●	●		●	●	●	●	●		●	●	●			●				●			●	●	
Cornus stolonifera Yellowtwig Dogwood	●		●	●			●	●	●	●	●				●		●	●	●				●	
Cotoneaster species Cotoneaster		●		●	●	●	●	●		●	●	●			●		●	●			●			
Euonymus alatus Winged Euonymous	●			●	●	●	●	●		●	●	●			●		●	●	●	●			●	
Forsythia 'Arnold Dwarf' Dwarf Forsythia	●					●	●		●		●				●	●		●					●	
Ilex crenata species Japanese Holly		●		●	●	●	●	●		●	●	●			●	●	●	●	●				●	
Ilex cornuta 'burfordi' Burford Holly		●		●	●	●	●	●			●	●			●		●	●	●				●	
Ilex glabra Inkberry		●		●	●	●	●	●	●	●	●	●				●	●	●	●	●		●	●	
Ilex verticillata Winterberry		●				●	●	●	●	●	●				●	●	●	●	●			●		
Ilex vomitoria nana Dwarf Yaupon Holly		●		●	●	●	●	●		●	●				●	●	●	●	●				●	●
Juniper species Juniper		●		●	●	●	●	●	●	●	●	●			●	●	●	●			●		●	

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3.Landscape

3.6

Plant Matrix

GW TH TT TP SS OS FA FH CS

6 of 7

Botanical Name

Common Name

SHRUBS (continued)

Ligustrum lucidum
Ligustrum

Ligustrum obtusifolium
Regal Privet

Mahonia bealei
Leatherleaf Mahonia

Myrica cerifera
Southern Waxmyrtle

Pieris japonica
Japanese Pieris

Pinus mugo
Mugo Pine

Rhododendron species
Rhododendron

Syringa vulgaris
Common Purple Lilac

Taxus cuspidata
Japanese Yew

Viburnum species
Viburnum

Type	Visual Zone											Appl.		Exp.	Soil								
Deciduous																							
Evergreen																							
Indigenous																							
GW																							
TH																							
TT																							
TP																							
SS																							
OS																							
FA																							
FH																							
CS																							
Shade																							
Street Tree																							
Ornamental Interest																							
Screen																							
Erosion Control																							
Sun																							
Partial Shade																							
Shade																							
Dry																							
Moist																							
Adaptable																							
Salt Tolerant																							

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3.Landscape

3.6

Plant Matrix

GW TH TT TP SS OS FA FH CS

7 of 7

Botanical Name

Common Name

GROUND COVER

Ajuga reptans
Ajuga

Euonymus radicans coloratus
Wintercreeper

Hedera helix
English Ivy

Juniper species
Juniper

Liriope spicata
Lilyturf

Pachysandra terminalis
Japanese Spurge

Vinca minor
Periwinkle

Type	Visual Zone										Appl.		Exp.	Soil										
Deciduous																								
Evergreen																								
Indigenous																								
GW																								
TH																								
TT																								
TP																								
SS																								
OS																								
FA																								
FH																								
CS																								
Shade																								
Street Tree																								
Ornamental Interest																								
Screen																								
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Shade																								
Dry																								
Moist																								
Adaptable																								
Salt Tolerant																								

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Friday, July 23, 2010



REQUEST FOR PROPOSAL



APPENDIX-J

DRAWINGS

DJG, Inc.

B-101 – Overall Topographic Survey

C-101 – Overall Demolition Plan

C-102 – Overall Site Plan

C-103 – Barracks and Track Site and Utility Plan

C-104 – Barracks and Track Site Grading Plan

C-105 – Dining Facility and Parking Grading Plan

C-106 – Storm Sewer Profile and Details

Center of Standardization (COS)

A101 – Barracks/Company Operations (B/COF) First Floor Plan

A102 – Barracks/Company Operations (B/COF) Second Floor Plan

A103 – Barracks/Company Operations (B/COF) Third Floor Plan

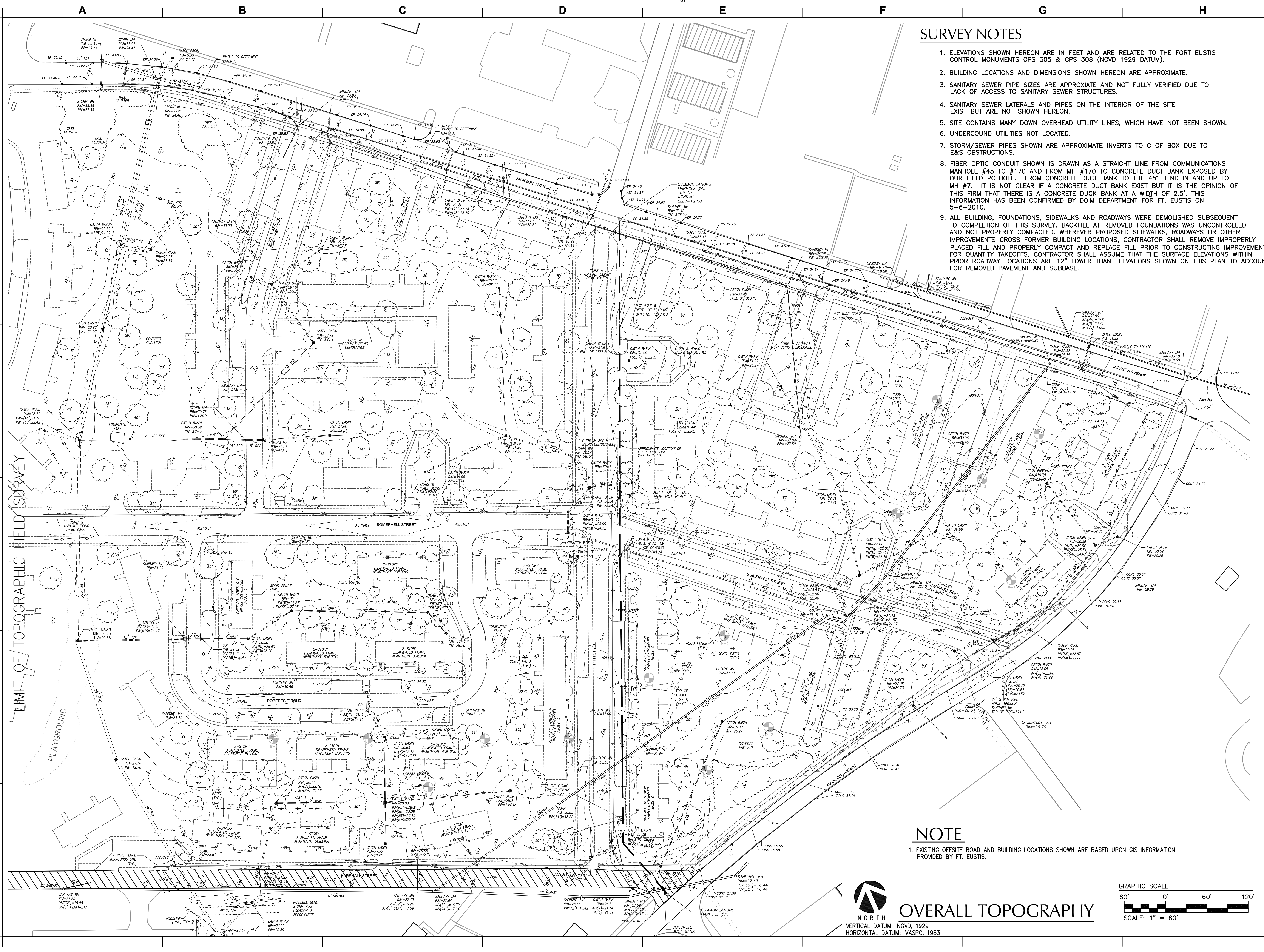
Room Module

A605 – Covered Assembly Area

A803 – Lawn Equipment Building

Attachment A – PT Pit Climbing Bars

Attachment B – Typical Track Cross Section



SURVEY NOTES

- 1. ELEVATIONS SHOWN HEREON ARE IN FEET AND ARE RELATED TO THE FORT EUSTIS CONTROL MONUMENTS GPS 305 & GPS 308 (NGVD 1929 DATUM).
- 2. BUILDING LOCATIONS AND DIMENSIONS SHOWN HEREON ARE APPROXIMATE.
- 3. SANITARY SEWER PIPE SIZES ARE APPROXIMATE AND NOT FULLY VERIFIED DUE TO LACK OF ACCESS TO SANITARY SEWER STRUCTURES.
- 4. SANITARY SEWER LATERALS AND PIPES ON THE INTERIOR OF THE SITE EXIST BUT ARE NOT SHOWN HEREON.
- 5. SITE CONTAINS MANY DOWN OVERHEAD UTILITY LINES, WHICH HAVE NOT BEEN SHOWN.
- 6. UNDERGROUND UTILITIES NOT LOCATED.
- 7. STORM/SEWER PIPES SHOWN ARE APPROXIMATE INVERTS TO C OF BOX DUE TO E&S OBSTRUCTIONS.
- 8. FIBER OPTIC CONDUIT SHOWN IS DRAWN AS A STRAIGHT LINE FROM COMMUNICATIONS MANHOLE #45 TO #170 AND FROM MH #170 TO CONCRETE DUCT BANK EXPOSED BY OUR FIELD POT HOLE. FROM CONCRETE DUCT BANK TO THE 45° BEND IN AND UP TO MH #7. IT IS NOT CLEAR IF A CONCRETE DUCT BANK EXIST BUT IT IS THE OPINION OF THIS FIRM THAT THERE IS A CONCRETE DUCT BANK AT A WIDTH OF 2.5'. THIS INFORMATION HAS BEEN CONFIRMED BY DOIM DEPARTMENT FOR FT. EUSTIS ON 5-6-2010.
- 9. ALL BUILDING, FOUNDATIONS, SIDEWALKS AND ROADWAYS WERE DEMOLISHED SUBSEQUENT TO COMPLETION OF THIS SURVEY. BACKFILL AT REMOVED FOUNDATIONS WAS UNCONTROLLED AND NOT PROPERLY COMPACTED. WHEREVER PROPOSED SIDEWALKS, ROADWAYS OR OTHER IMPROVEMENTS CROSS FORMER BUILDING LOCATIONS, CONTRACTOR SHALL REMOVE IMPROPERLY PLACED FILL AND PROPERLY COMPACT AND REPLACE FILL PRIOR TO CONSTRUCTING IMPROVEMENTS. FOR QUANTITY TAKEOFFS, CONTRACTOR SHALL ASSUME THAT THE SURFACE ELEVATIONS WITHIN PRIOR ROADWAY LOCATIONS ARE 12" LOWER THAN ELEVATIONS SHOWN ON THIS PLAN TO ACCOUNT FOR REMOVED PAVEMENT AND SUBBASE.

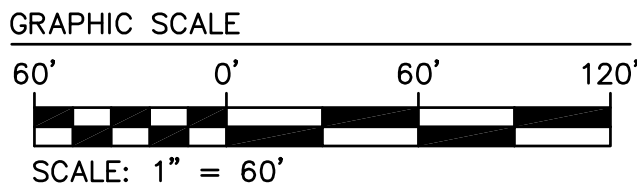
NOTE

- 1. EXISTING OFFSITE ROAD AND BUILDING LOCATIONS SHOWN ARE BASED UPON GIS INFORMATION PROVIDED BY FT. EUSTIS.



OVERALL TOPOGRAPHY

VERTICAL DATUM: NGVD, 1929
HORIZONTAL DATUM: VASPC, 1983



US Army Corps of Engineers
Norfolk District

Rev.	Date	Description	Mark
1			
2			
3			
4			
5			
6			

Designed by: JUC	Rev. 6/28/2010	File no. Norfolk District
Dwn by: BMB	Old by: KMS	Project no. 1
Reviewed by: JW	File name: 2100341-01.dwg	Plot date: 6/28/2010
DUG Commission: 2100341	Plot scale: AS NOTED	

ENGINEERS • ARCHITECTS
PLANNERS

4400 Midland Circle, Alexandria, VA 22306
703.299.1234
www.djp.com

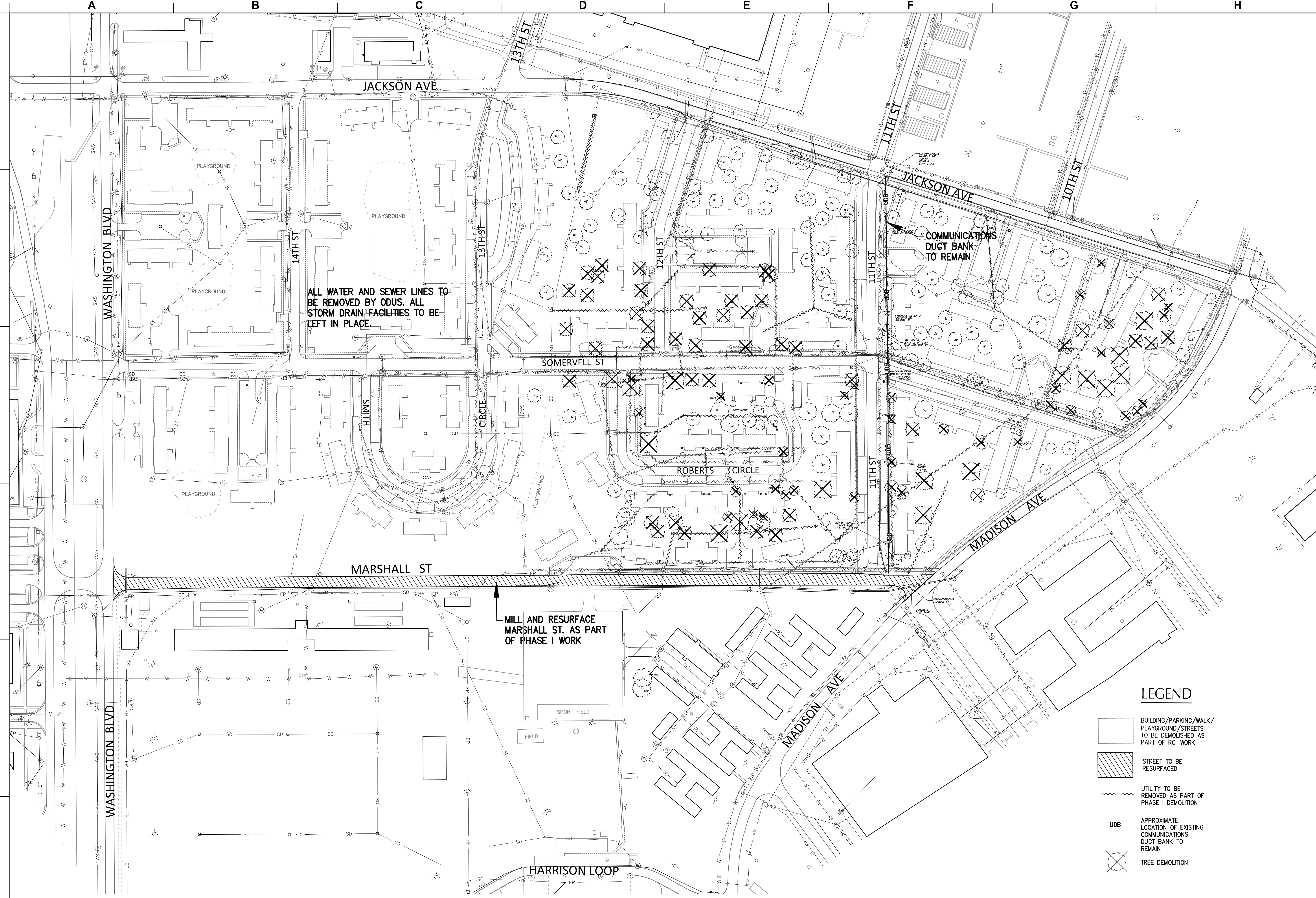
US ARMY CORPS OF ENGINEERS
AIR FACILITY
FORT EUSTIS, VIRGINIA

OVERALL TOPOGRAPHIC SURVEY

SHEET
REFERENCE
NUMBER

B-101

Sheet 1 of 7



OVERALL DEMOLITION PLAN

LEGEND

- BUILDING/PARKING/WALK/PLAYGROUND/STREETS TO BE DEMOLISHED AS PART OF RCI WORK
- STREET TO BE RESURFACED
- UTILITY TO BE REMOVED AS PART OF PHASE I DEMOLITION
- APPROXIMATE LOCATION OF EXISTING COMMUNICATIONS DUCT BANK TO REMAIN
- TREE DEMOLITION

GRAPHIC SCALE
100' 0' 100' 200'
SCALE: 1" = 100'

US Army Corps of Engineers
Norfolk District

Mark	Description	Date	Appr.

Designed by: BMB	Rev. 6/28/2010	Rev. File no.
Dwn by: BMB	Old by: KMS	Norfolk District File no.
Reviewed by: JW	Project no.	
DUG Commission:	File name: 2100341-01.dwg	Plot date: 6/28/2010
2100341	Plot scale: As noted	

ENGINEERS • ARCHITECTS
PLANNERS

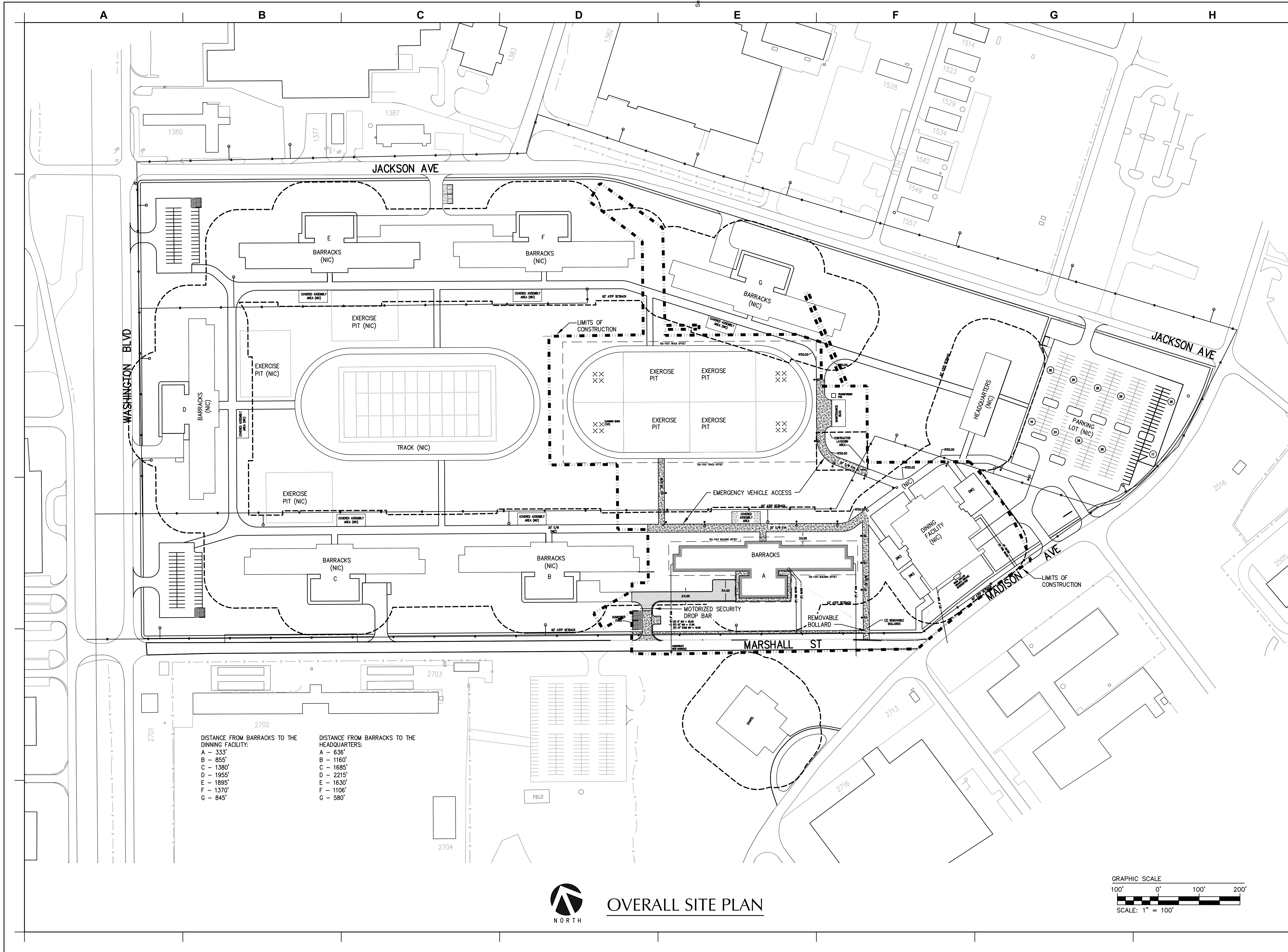
DGP, INC.
4401 Lakeside Dr., Williamsburg, VA 23186
Phone: 757/265-1234
Fax: 757/265-1235
www.dgp.com

COMMITTED TO EXCELLENCE

US ARMY CORPS OF ENGINEERS
FORT EUSTIS, VIRGINIA

OVERALL DEMOLITION PLAN

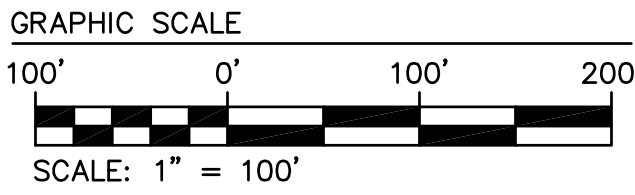
SHEET
REFERENCE
NUMBER
C-101
Sheet 2 of 7



DISTANCE FROM BARRACKS TO THE DINING FACILITY:		DISTANCE FROM BARRACKS TO THE HEADQUARTERS:	
A - 333'		A - 636'	
B - 855'		B - 1160'	
C - 1380'		C - 1685'	
D - 1955'		D - 2215'	
E - 1895'		E - 1630'	
F - 1370'		F - 1106'	
G - 845'		G - 580'	



OVERALL SITE PLAN



US Army Corps of Engineers
Norfolk District

Mark	Description	Date	Appr.

Date: 7/1/2010
Norfolk District File no.
Designed by: JUC
Dwn by: BMB Cld by: KMS
Reviewed by: JW
Project no.
File name: 2100341-01-0000.dwg
Plot date: 7/1/2010
Plot scale: As noted

Rev.
Norfolk District File no.
Project no.
DUG Commission: 2100341

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PLANNERS

4400 MacLean Drive, Williamsburg, VA 23186
Phone: 757/261-2219
Fax: 757/261-2219
www.djpinc.com

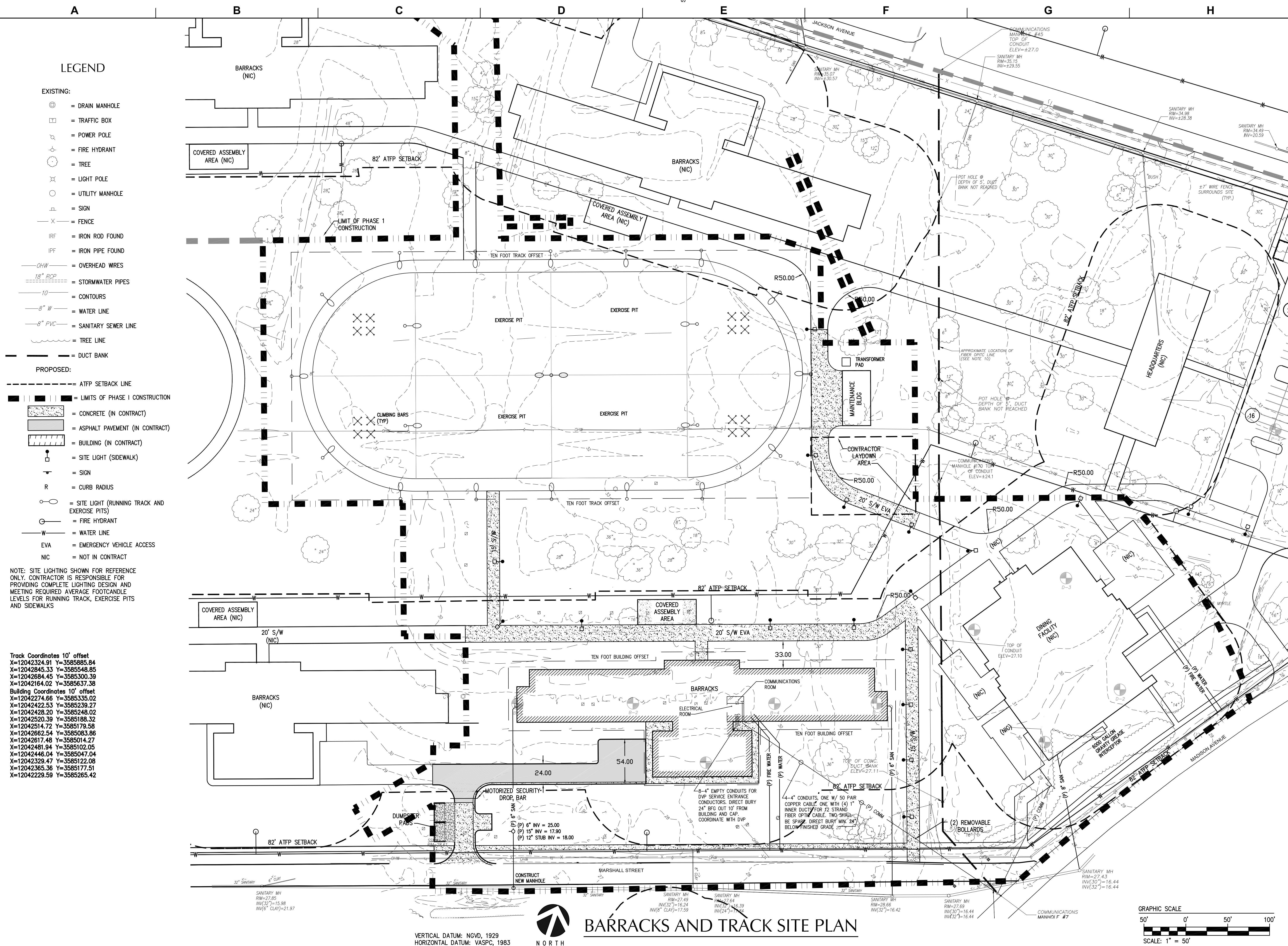
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TO EXCELLENCE

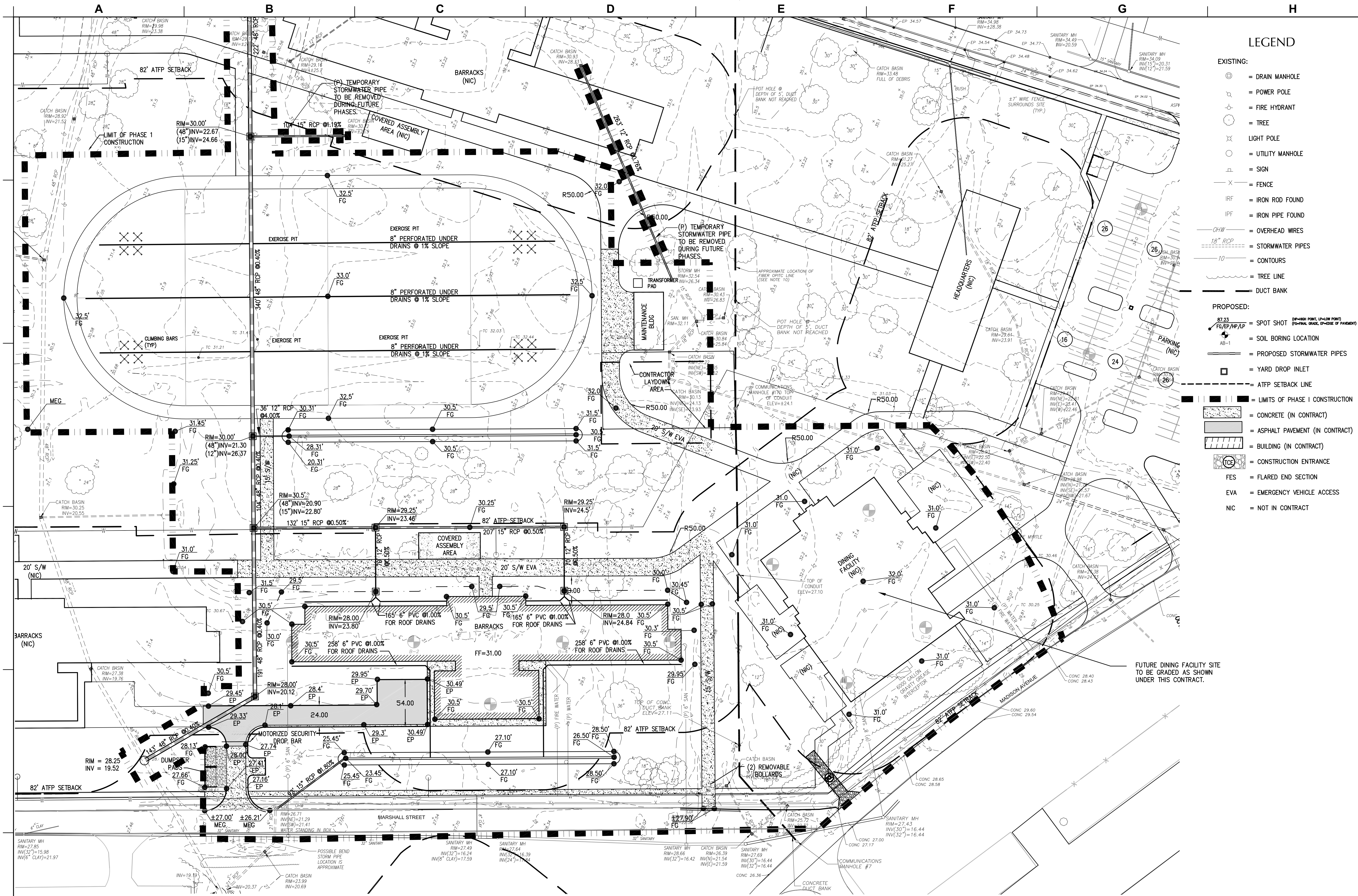
US ARMY CORPS OF ENGINEERS
FORT EUSTIS, VIRGINIA

OVERALL SITE PLAN

SHEET
REFERENCE
NUMBER
C-102

Sheet 3 of 7

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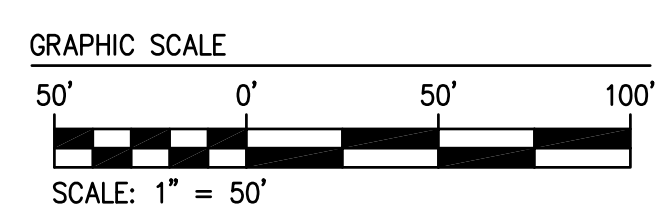


LEGEND

- EXISTING:
- = DRAIN MANHOLE
 - ⊕ = POWER POLE
 - ⊙ = FIRE HYDRANT
 - ⊗ = TREE
 - ⊕ = LIGHT POLE
 - = UTILITY MANHOLE
 - ⊕ = SIGN
 - X — = FENCE
 - IRF = IRON ROD FOUND
 - IPF = IRON PIPE FOUND
 - OHW — = OVERHEAD WIRES
 - 18" RCP — = STORMWATER PIPES
 - 10 — = CONTOURS
 - — = TREE LINE
 - — = DUCT BANK
- PROPOSED:
- 87.23 FG/EP/HP/LP = SPOT SHOT (SP-100 POINT, L-100 POINT) (SP-100 POINT, L-100 POINT)
 - AB-1 = SOIL BORING LOCATION
 - — = PROPOSED STORMWATER PIPES
 - = YARD DROP INLET
 - — = ATFP SETBACK LINE
 - ■ ■ ■ ■ = LIMITS OF PHASE I CONSTRUCTION
 - ■ ■ ■ ■ = CONCRETE (IN CONTRACT)
 - ■ ■ ■ ■ = ASPHALT PAVEMENT (IN CONTRACT)
 - ■ ■ ■ ■ = BUILDING (IN CONTRACT)
 - ⊕ = CONSTRUCTION ENTRANCE
 - FES = FLARED END SECTION
 - EVA = EMERGENCY VEHICLE ACCESS
 - NIC = NOT IN CONTRACT

GENERAL NOTES

1. THE CONTRACTOR IS RESPONSIBLE FOR DESIGNING AND PROVIDING THE STORMWATER MANAGEMENT AND EROSION AND SEDIMENT CONTROL PLANS.
2. NATURAL GAS, ELECTRICAL, WATER, AND SANITARY ARE PRIVATIZED UTILITIES AND WILL BE BROUGHT TO WITHIN 5 FOOT OF THE BUILDING BY THE UTILITY PROVIDERS. THE CONTRACTOR WILL PROVIDE THE CONNECTION FOR THE BUILDING TO THAT POINT.



NORTH
VERTICAL DATUM: NGVD, 1929
HORIZONTAL DATUM: VASPC, 1983

BARRACKS AND TRACK SITE GRADING PLAN

US Army Corps of Engineers
Norfolk District

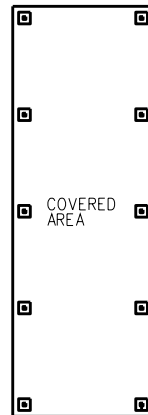
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2				
3				
4				
5				
6				

Designed by: JUC	Rev. 7/1/2010	File no. Norfolk District File no.
Dwn by: JUC	Ok'd by: KMS	Project no. 2100341
Reviewed by: JUC	File name: 2100341.dwg	Plot date: 7/1/2010
DWG Commissioned:	2100341	Plot scale: AS SHOWN

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DJG
4400 Midland Circle, Suite 200, Norfolk, VA 23505
Phone: 757/261-1234 Fax: 757/261-1235
www.djginc.com

US ARMY CORPS OF ENGINEERS
FORT EUSTIS, VIRGINIA
BARRACKS AND TRACK SITE
GRADING PLAN

SHEET
REFERENCE
NUMBER
C-104
Sheet 5 of 7



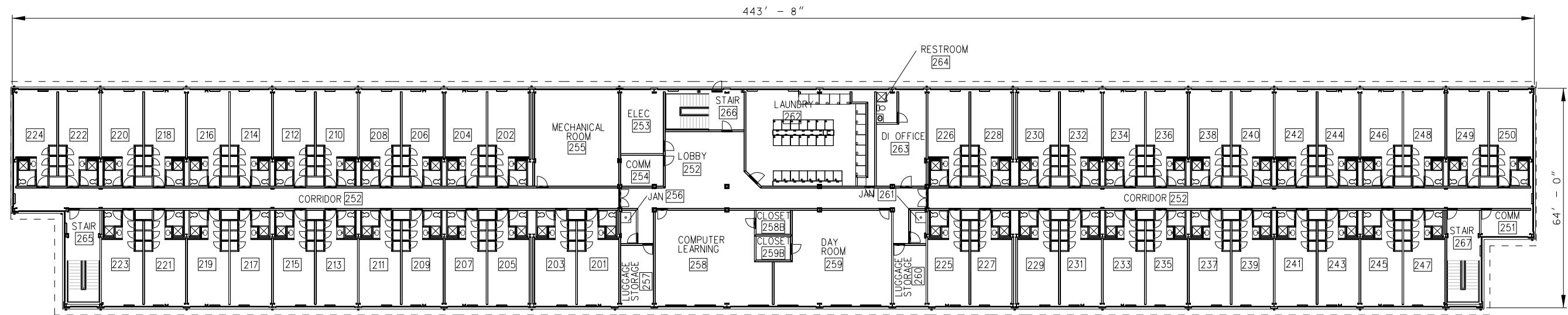
1 1ST FLOOR PLAN

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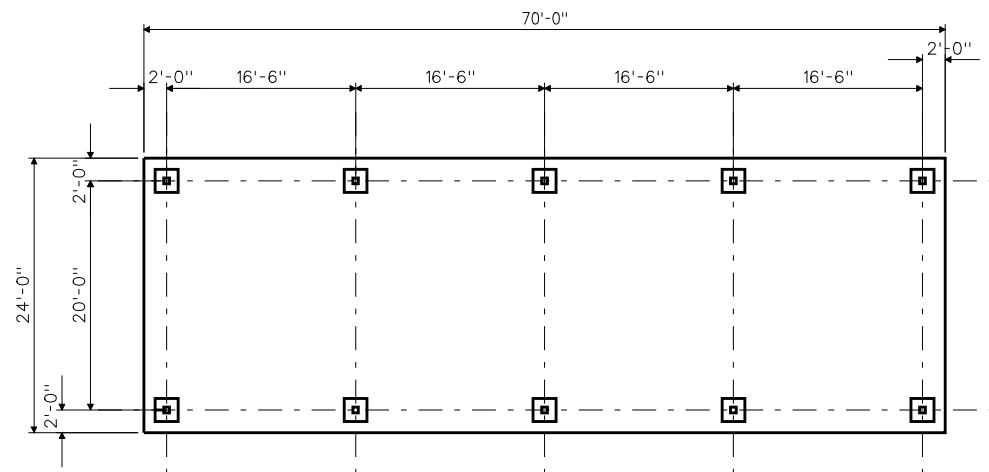
ENGINEERING/ CONSTRUCTION DIVISION DESIGN BRANCH	Reviewed by: BILL BOYLE		Contr. No.
	Submitted by: BILL BOYLE, AIA		
	Checked by: ANTHONY PUGH For date: 5/25/2010 Post code:		
U.S. ARMY ENGINEER DISTRICT, CORPS OF ENGINEERS FORT WORTH, TEXAS	Date by: EDWARD GITZLER	Sol. No.	Case No.

FLOOR PLAN
1ST FLOOR

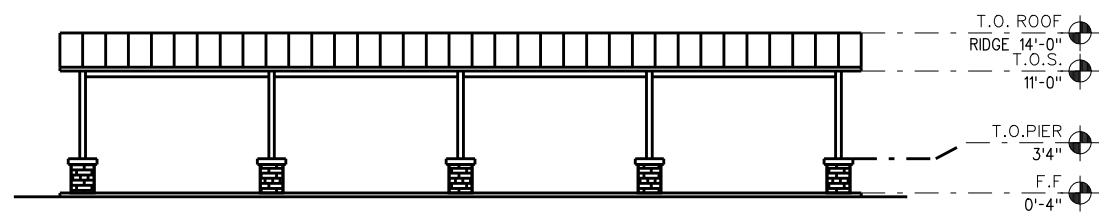
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number:
A101



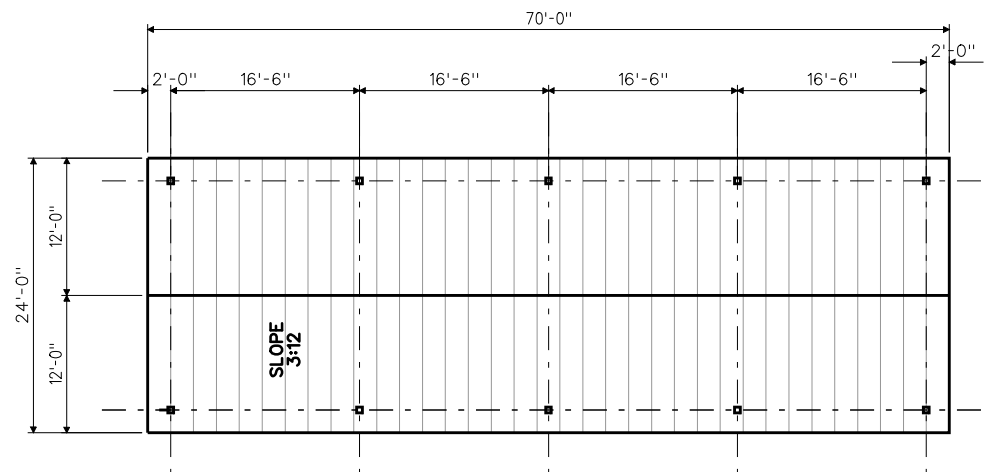
1 2nd FLOOR PLAN



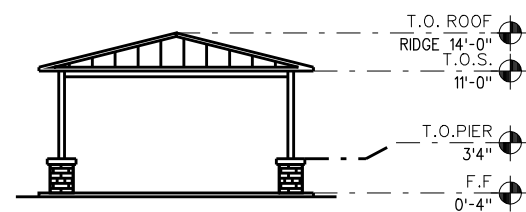
1 COVERED ASSEMBLY AREA PLAN
1/8" = 1'-0"



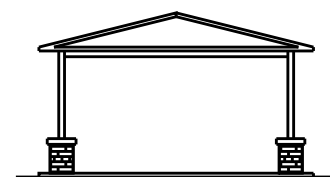
3 COVERED ASSEMBLY AREA ELEVATION
1/8" = 1'-0"



2 COVERED ASSEMBLY AREA ROOF PLAN
1/8"=1'-0"



4 COVERED ASSEMBLY AREA ELEVATION



5 COVERED ASSEMBLY AREA SECTION
1/8"=1'-0"

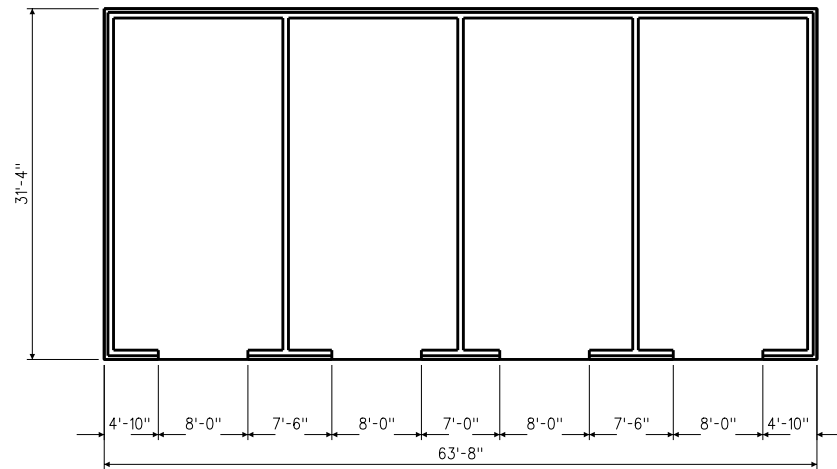
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	Dwn by:	Sol No.	
	Reviewed by:	Contr. No.	
	Submitted by: BILL BOYLE, AIA CHIEF, ARCHITECTURAL SECTION Post scale: 6/29/2009		
	Job name: 150000 000 000 000		

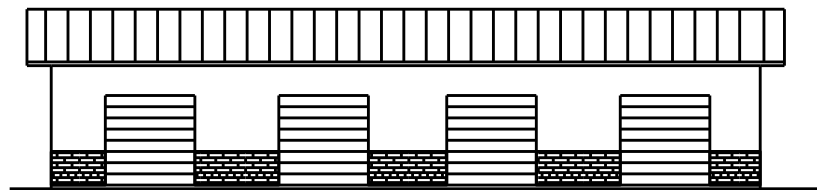
CENTER OF STANDARDIZATION
ADVANCED INDIVIDUAL TRAINING
BARRACKS COMPANY OPERATIONS FACILITY
PN:
COVERED ASSEMBLY AREA

Sheet
reference
number:
A605

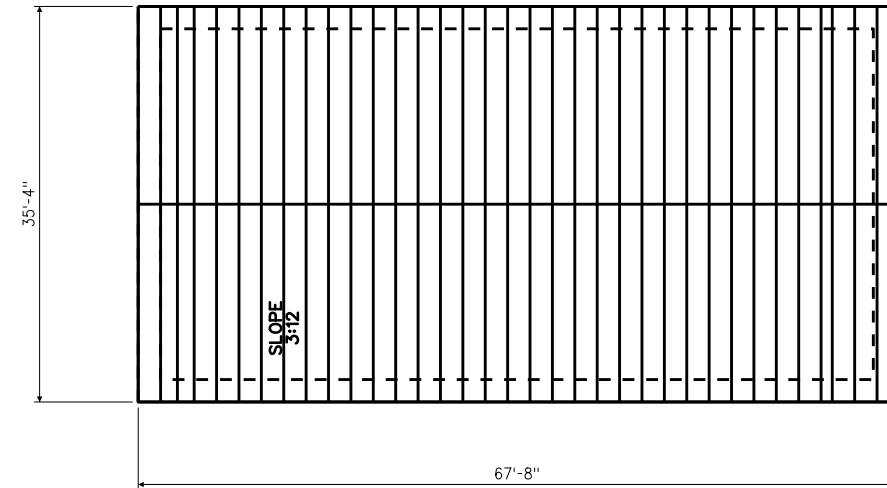
Section:



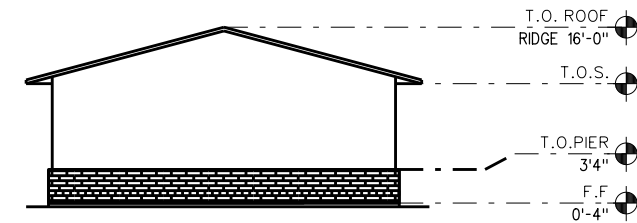
1 LAWN EQUIPMENT BUILDING PLAN
1/8"=1'-0"



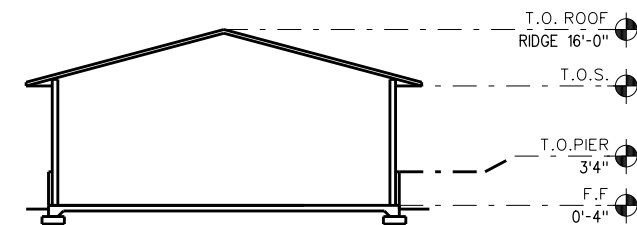
3 LAWN EQUIPMENT BUILDING ELEVATION
1/8"=1'-0"



2 LAWN EQUIPMENT BUILDING ROOF PLAN
1/8"=1'-0"



4 LAWN EQUIPMENT BUILDING ELEVATION
1/8" = 1'-0"



6 LAWN EQUIPMENT BUILDING SECTION
1/8"=1'-0"

NOTE: SEE SHEET E-402
FOR ELECTRICAL PLANS



US Army Corps
of Engineers
Fort Worth District

[illegible]

U.S. ARMY ENGINEER DISTRICT, CORPS OF ENGINEERS FORT WORTH, TEXAS	Designed by:	Date:	Rev.
	Dwn by:	Sol No.	
ENGINEERING/ CONSTRUCTION DIVISION DESIGN BRANCH	Reviewed by:	Contr No.	
	Submitted by:	Job no. 7-652734-A-603-.... Plot date 3/18/2010 Plot scale:	

CENTER OF STANDARDIZATION
ADVANCED INDIVIDUAL TRAINING
BARRACKS COMPANY OPERATIONS FACILITY

LAWN EQUIPMENT
BUILDING

Sheet
reference
number:
A803

Contr. No.

ATTACHMENT A

Climbing Bars



Figure B-1.

Climbing Bars Specifications

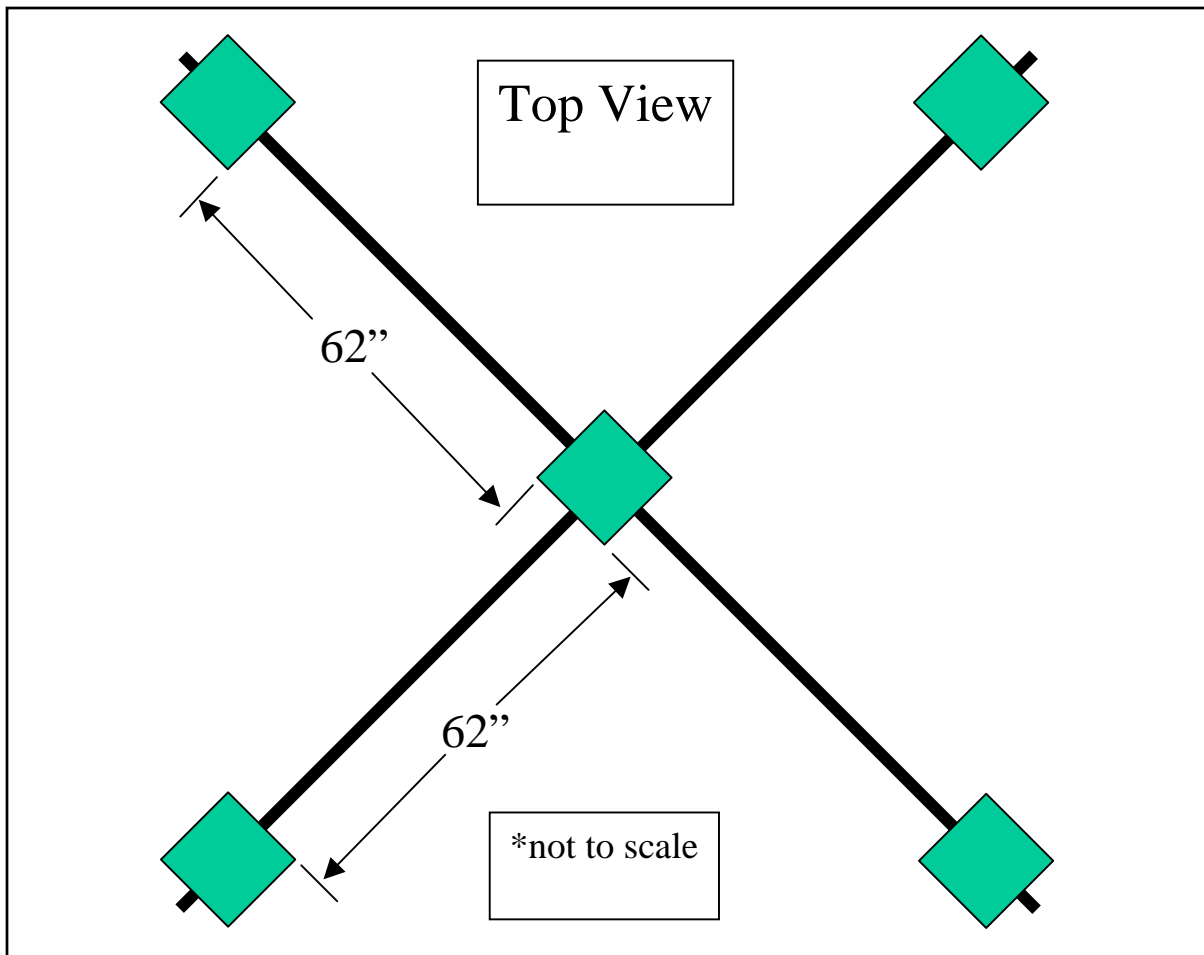


Figure B-2.

The specifications for the climbing bars are as follows:

- ❑ The posts (5) are 6" x 6" x 12' and sunk 3 feet into the ground, anchored with concrete.
- ❑ The bars (2) are threaded water pipe, 1.0 inch inside diameter, 12 feet long with 1-inch end caps (4).
- ❑ The bars are through the 6x6s at 7.5 and 8 feet above the ground.
- ❑ The distance from inside post edge to inside post edge is approximately 62 inches (refer to Figure B-2). This is to allow enough bar space to conduct all exercises safely.
- ❑ The step-ups (16 inches long) are cut from 4" x 4" x 8' posts and secured to the 6x6s with 3 inch screws that are counter sunk.
- ❑ The step-ups on the outside 6x6 posts are 18 inches from the ground, the step-ups on the inside post are 24 inches above the ground (refer to Figure DB-3).

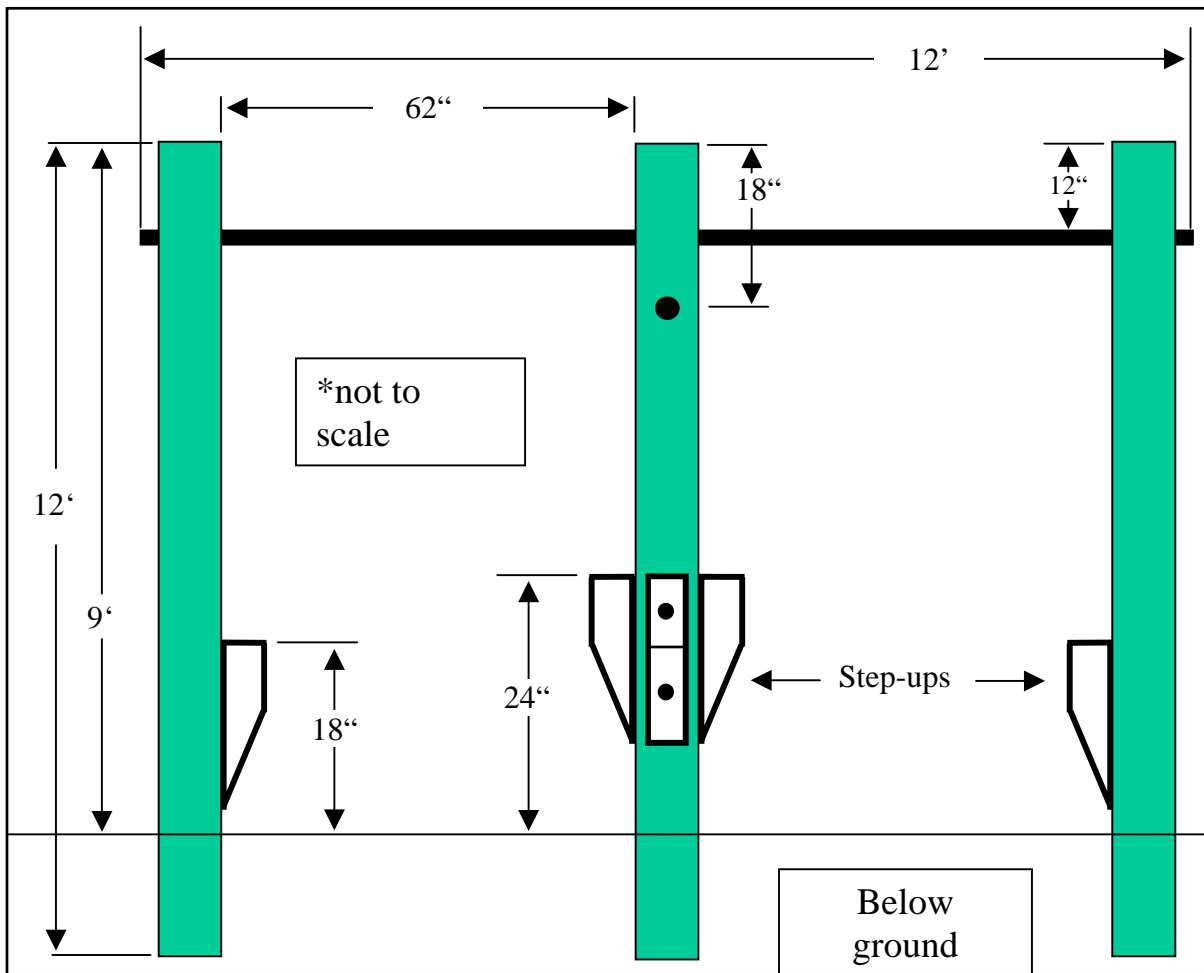


Figure B-3.

The following planning considerations apply:

- ❑ Climbing bars provide adequate space and facilitate better command and control than traditional pull-up bars. Traditional pull-up bars are too narrow to safely and efficiently conduct the climbing drills.
- ❑ Employment of multiple climbing bar “pods” as shown in Figure B-4 will allow for efficient mass training. The climbing drills require one bar for every three soldiers when performed as a single activity.
- ❑ The total ground surface area for four pods is only 625 square feet.
- ❑ Four pods will accommodate 16 stations x 3 soldiers per station for a total of 48 soldiers.
- ❑ Additional free-standing pods should be constructed to accommodate more soldiers.

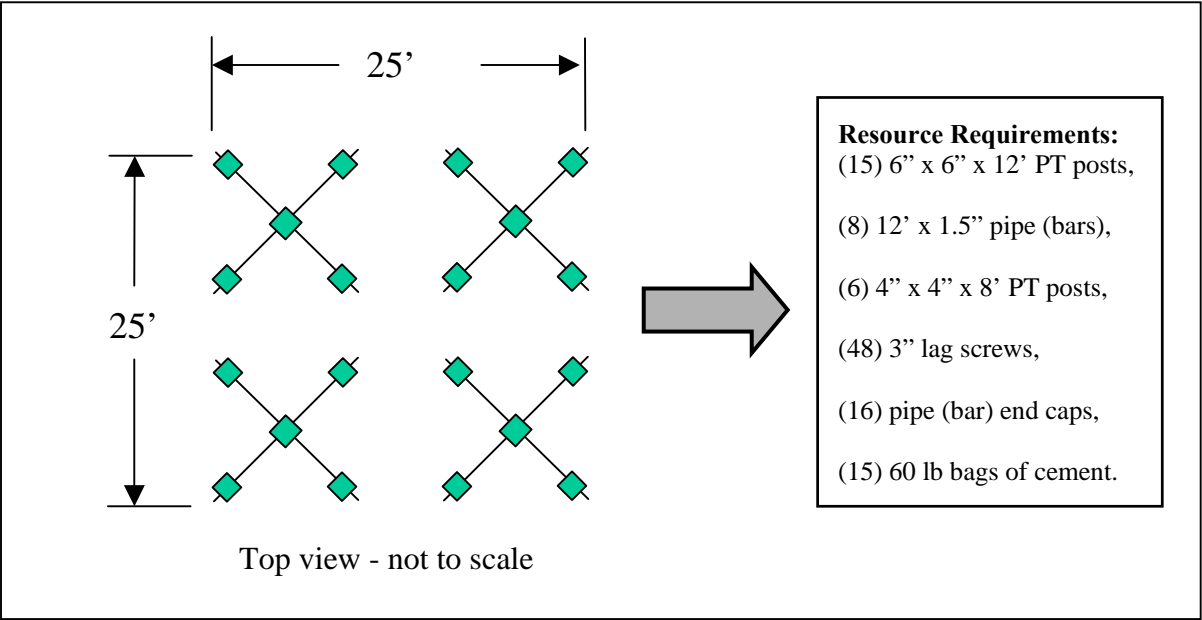
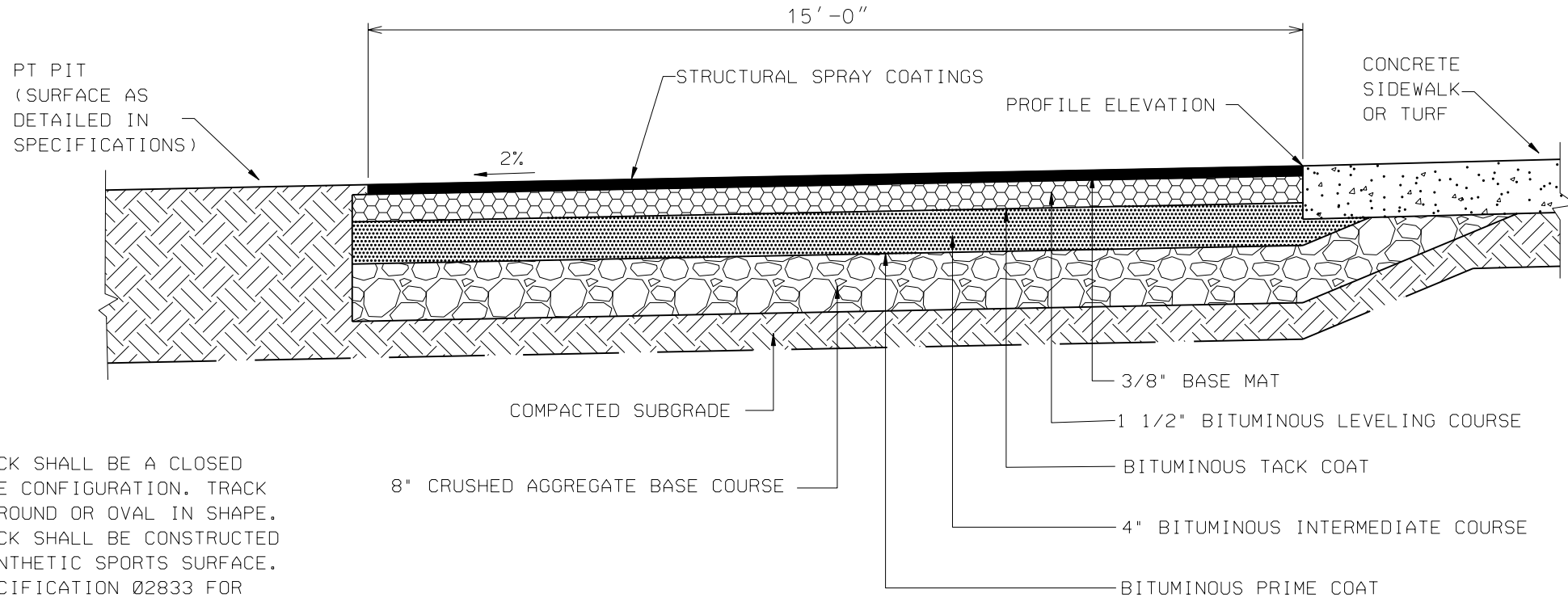


FIGURE B-4.

Section:

ATTACHMENT B



NOTE:

THE TRACK SHALL BE A CLOSED 1/4 MILE CONFIGURATION. TRACK MAY BE ROUND OR OVAL IN SHAPE. THE TRACK SHALL BE CONSTRUCTED OF A SYNTHETIC SPORTS SURFACE. SEE SPECIFICATION 02833 FOR MATERIAL AND INSTALLATION REQUIREMENTS. TRACK AND PT PITS SHALL BE DESIGNED WITH SURFACE AND/OR SUBSURFACE DRAINAGE, AS REQUIRED TO ELIMINATE ALL STANDING WATER.

ATHLETIC RUNNING TRACK TYPICAL CROSS SECTION

NOT TO SCALE

FIGURE 2- RUNNING TRACK

APPENDIX K Fuel Cost Information

The following utility rates for this installation are provided for design

Electrical:

Demand Charge - \$xx.xx per kilowatt

Energy Charge - \$ x.xx per kilowatt-hour Blended Rate - \$ x.xx per kilowatt-hour (blended annual energy and demand cost)

Natural Gas:

Commodity Charge Rate - \$ x.xx per thousand cubic feet

Water:

Commodity Charge Rate - \$x.xx per [volume]

Sewer:

Commodity Charge Rate - \$x.xx per [volume]

Purchased/Central Steam:

Commodity Charge Rate - \$x.xx per [unit of measure]

Purchased High Temperature Water:

Commodity Charge Rate - \$x.xx per [unit of measure]

Purchased Chilled Water:

Commodity Charge Rate - \$x.xx per [unit of measure]

APPENDIX L**LEED Project Credit Guidance (MAY 10)**

This spreadsheet indicates Army required credits, Army preferred credits, project-specific ranking of individual point preferences, assumptions guidance for individual credits, and references to related language in the RFP for individual credits.

	LEED Credit Paragraph		Army Guidance: Required - Preferred - Avoid	Project Preference Ranking: (1=most preferred, blank=no preference, X=preference not applicable to this credit, Rqd=required)	
		LEED Project Credit Guidance			
PAR		FEATURE			REMARKS
<u>SUSTAINABLE SITES</u>					
SSPR1		Construction Activity Pollution Prevention (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met.
SS1		Site Selection		X	See paragraph LEED CREDITS COORDINATION.

SS2	Development Density & Community Connectivity - OPTION 1 DENSITY		X	See paragraph LEED CREDITS COORDINATION.
	Development Density & Community Connectivity - OPTION 2 CONNECTIVITY		X	See paragraph LEED CREDITS COORDINATION.
SS3	Brownfield Redevelopment		X	See paragraph LEED CREDITS COORDINATION.
SS4.1	Alternative Transportation: Public Transportation Access		X	See paragraph LEED CREDITS COORDINATION.
SS4.2	Alternative Transportation: Bicycle Storage & Changing Rooms	Pref		Assume that non-transient building occupants are NOT housed on Post unless indicated otherwise.
SS4.3	Alternative Transportation: Low Emitting & Fuel Efficient Vehicles - OPTION 1			Requires provision of vehicles, which cannot be purchased with construction funds. Assume Government will not provide vehicles unless indicated otherwise. Assume that 50% of GOV fleet is NOT alternative fuel vehicles unless indicated otherwise.
SS4.3	Alternative Transportation: Low Emitting & Fuel Efficient Vehicles - OPTION 2	Pref		
SS4.3	Alternative Transportation: Low Emitting & Fuel Efficient Vehicles - OPTION 3			Requires provision of vehicle refueling stations. Installation must support type of fuel and commit to maintaining/supporting refueling stations.
SS4.4	Alternative Transportation: Parking Capacity	Pref		

SS5.1	Site Development: Protect or Restore Habitat			
SS5.2	Site Development: Maximize Open Space	Pref		Assume AGMBC option for aggregated open space at another location on the installation is not available to the project unless indicated otherwise.
SS6.1	Stormwater Design: Quantity Control	Pref		See paragraph STORMWATER MANAGEMENT.
SS6.2	Stormwater Design: Quality Control	Pref		See paragraph STORMWATER MANAGEMENT.
SS7.1	Heat Island Effect: Non-Roof			
SS7.2	Heat Island Effect: Roof	Pref		Coordinate with nearby airfield requirements, which may preclude this credit.
SS8	Light Pollution Reduction	Pref		
<u>WATER EFFICIENCY</u>				
WEPR1	Water Use Reduction (Version 3 only)	Rqd	Rqd	All LEED prerequisites are required to be met.
WE1.1	Water Efficient Landscaping: Reduce by 50%	Pref		See paragraph IRRIGATION. Project must include landscaping to be eligible for this credit.
WE1.2	Water Efficient Landscaping: No Potable Water Use or No Irrigation	Pref		Project must include landscaping to be eligible for this credit.
WE2	Innovative Wastewater Technologies - OPTION 1			
WE2	Innovative Wastewater Technologies - OPTION 2			
WE3	Water Use Reduction	Pref		See paragraph BUILDING WATER USE REDUCTION.

ENERGY AND ATMOSPHERE				
EAPR1	Fundamental Commissioning of the Building Energy Systems (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met.
EAPR2	Minimum Energy Performance (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met.
EAPR3	Fundamental Refrigerant Management (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met.
EA1	Optimize Energy Performance	Rqd	1	Earning of LEED EA1 points as indicated in paragraph ENERGY CONSERVATION , as a minimum, is required.
EA2.1	On-Site Renewable Energy	Pref		See paragraph ENERGY CONSERVATION .
EA3	Enhanced Commissioning	Rqd		See paragraph COMMISSIONING . The Commissioning Authority may be provided through the Design-Build Contractor only if in accordance with USGBC Credit Interpretation Ruling (CIR) dated 9/15/06. Commissioning Authority activities begin during design phase and continue well beyond beneficial occupancy. Assume Government will not provide CxA post-occupancy activities unless indicated otherwise.
EA4	Enhanced Refrigerant Management			
EA5	Measurement & Verification			Assume Government will not provide post-occupancy activities unless indicated otherwise.
EA6	Green Power		X	See paragraph LEED CREDITS COORDINATION .

MATERIALS AND RESOURCES				
MRPR1	Storage & Collection of Recyclables (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met. Coordinate with Installation during design development on collection service and receptacles.
MR1	Building Reuse			
MR2.1	Construction Waste Management: Divert 50% From Disposal	Pref		See paragraph CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT.
MR2.2	Construction Waste Management: Divert 75% From Disposal	Pref		
MR3	Materials Reuse			
MR4.1	Recycled Content: 10% (post-consumer + 1/2 pre-consumer)	Pref		See paragraph RECYCLED CONTENT.
MR4.2	Recycled Content: 20% (post-consumer + 1/2 pre-consumer)	Pref		
MR5.1	Regional Materials:10% Extracted, Processed & Manufactured Regionally			
MR5.2	Regional Materials:20% Extracted, Processed & Manufactured Regionally			

MR6	Rapidly Renewable Materials	Pref		See paragraph BIOBASED AND ENVIRONMENTALLY PREFERABLE MATERIALS and paragraph FEDERAL BIOBASED PRODUCTS PREFERRED PROCUREMENT PROGRAM.
MR7	Certified Wood	Pref		See paragraph BIOBASED AND ENVIRONMENTALLY PREFERABLE MATERIALS.
<u>INDOOR ENVIRONMENTAL QUALITY</u>				
EQPR1	Minimum IAQ Performance (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met.
EQPR2	Environmental Tobacco Smoke (ETS) Control (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met. Assume all buildings are smoke free unless indicated otherwise (family housing, barracks and other lodging are facility types where smoking may be permitted in some cases).
EQ1	Outdoor Air Delivery Monitoring			
EQ2	Increased Ventilation			
EQ3.1	Construction IAQ Management Plan: During Construction	Pref		See paragraph CONSTRUCTION IAQ MANAGEMENT.
EQ3.2	Construction IAQ Management Plan: Before Occupancy	Pref		See paragraph CONSTRUCTION IAQ MANAGEMENT.
EQ4.1	Low Emitting Materials: Adhesives & Sealants	Pref		See paragraph LOW-EMITTING MATERIALS.
EQ4.2	Low Emitting Materials: Paints & Coatings	Pref		See paragraph LOW-EMITTING MATERIALS.
EQ4.3	Low Emitting Materials: Carpet/Flooring Systems	Pref		See paragraph LOW-EMITTING MATERIALS.

EQ4.4	Low Emitting Materials: Composite Wood & Agrifiber Products	Pref		See paragraph LOW-EMITTING MATERIALS.
EQ5	Indoor Chemical & Pollutant Source Control	Pref		System requiring weekly cleaning to earn this credit is not a permitted option unless indicated otherwise.
EQ6.1	Controllability of Systems: Lighting			
EQ6.2	Controllability of Systems: Thermal Comfort			
EQ7.1	Thermal Comfort: Design	Rqd		See paragraph HEATING, VENTILATING AND AIR CONDITIONING.
EQ7.2	Thermal Comfort: Verification			Project must earn credit EQ7.1 to be eligible for this credit. Assume Government will not provide post-occupancy activities unless indicated otherwise.
EQ8.1	Daylight & Views: Daylight 75% of Spaces	Pref		See paragraph DAYLIGHTING.
EQ8.2	Daylight & Views: Views for 90% of Spaces	Pref		
INNOVATION & DESIGN PROCESS				
IDc1.1	Innovation in Design			See paragraph INNOVATION AND DESIGN CREDITS. Assume Government will not provide any activities associated with ID credits.
IDc1.2	Innovation in Design			
IDc1.3	Innovation in Design			
IDc1.4	Innovation in Design			
IDc2	LEED Accredited Professional	Rqd	Rqd	LEED AP during design and construction is required.
REGIONAL PRIORITY CREDITS (Version 3 only)				See paragraph LEED CREDITS COORDINATION.



REQUEST FOR PROPOSAL



APPENDIX-M

OWNER'S PROJECT REQUIREMENTS

01 FEB 07

Owner's Project Requirements Document for LEED Fundamental Commissioning

Project: Ft. Eustis AIT Complex – Phase 1 Barracks (PN 66714)

Approved:

Name

Owner's Representative

Date

Name

Design Agent's Representative

Date

Overview and Instructions

The purpose of this document is to provide clear and concise documentation of the Owner's goals, expectations and requirements for commissioned systems, and shall be utilized throughout the project delivery and commissioning process to provide an informed baseline and focus for design development and for validating systems' energy and environmental performance.

The Owner's Project Requirements Document is a required document for LEED Version 3.0 EA Prerequisite 1, Fundamental Commissioning of the Building Energy Systems. It shall be completed by the Corps District/Design Agent based on coordination with the Installation/User/Proponent and shall be approved by the Installation/User/Proponent representative.

Use of this template is not required, nor are there any restrictions on editing of it. It is provided simply as a tool to assist project teams in meeting the documentation requirements for LEED Fundamental Commissioning.

The intent of the Owner's Project Requirements Document, per the LEED v3.0 Reference Guide, is to detail the functional requirements of a project and the expectations of the building's use and operation as it relates to commissioned systems. This template contains the basic recommended components indicated in the LEED v3.0 Reference Guide. It should be adapted as needed to suit the project, remaining reflective of the LEED intent.

The Owner's Project Requirements Document should ideally be completed before the start of design and furnished to the design team. It must be completed prior to the approval of Contractor submittals of any commissioned equipment or systems to meet LEED requirements.

01 FEB 07

Updates to the Owner's Project Requirements Document throughout the course of project delivery shall be made by the Corps District/Design Agent based on decisions and agreements coordinated with and agreed to by the Installation/User/Proponent.

The Owner's Project Requirements Document shall be included in the project's LEED documentation file under EA PR1, Fundamental Commissioning of the Building Energy Systems.

01 FEB 07

Owner's Project Requirements Document for LEED Fundamental Commissioning

Table of Contents

1. Owner and User Requirements
 - Primary Purpose, Program and Use
 - Project History
 - Broad Goals
2. Environmental and Sustainability Goals
 - Energy Efficiency Goals
 - General
 - Siting
 - Building Façade
 - Building Fenestration
 - Building Envelope
 - Roof
 - Other
3. Indoor Environmental Quality Requirements
 - Intended Use
 - Occupancy Schedule
 - Accommodations for After-Hours Use
 - Lighting, Temperature, Humidity, Air Quality, Ventilation, Filtration
 - Acoustics
 - Occupant Ability to Adjust System Controls
 - Types of Lighting
4. Equipment and Systems Expectations
 - Space Heating
 - Ventilation
 - Air Conditioning
 - Refrigeration
 - HVAC Controls
 - Domestic Hot Water
 - Lighting Controls
 - Daylighting Controls
 - Emergency Power
 - Other
5. Building Occupant and O&M Personnel Requirements
 - Facility Operation
 - EMCS
 - Occupant Training and Orientation
 - O&M Staff Training and Orientation

TABLE 1

01 FEB 07

1. Owner and User Requirements

What is the primary purpose, program and use of this project? (example: office building with data center)

The facility will be used for barracks housing.

Describe pertinent project history. (example: standard design development)

Multiple charrettes were held to discuss the scope, size and appropriate use of the building.

Broad Goals

What are the broad goals relative to program needs?

To house soldiers during advanced individual training.

What are the broad goals relative to future expansion?

Future needs to be met by additional similar buildings in the same complex.

What are the broad goals relative to flexibility?

Building is purposed for housing and unit training and it is not intended for other purposes.

What are the broad goals relative to quality of materials?

The building materials are to provide approximately a 50 year lifespan.

What are the broad goals relative to construction costs?

Project cost should be in line with latest Form DD1391 prepared by the government.

What are the broad goals relative to operational costs?

Building is to meet the requirements of EPACT.

What are the broad goals relative to life cycle of the equipment?

01 FEB 07

Approximately 15-20 years lifespan.

Other broad goals: *(Insert as applicable)*

2. Environmental and Sustainability Goals

What are the project goals relative to sustainability and environmental issues? (example: LEED Silver rating)

The building is to attain at minimum LEED Silver certification.

What are the project goals relative to energy efficiency? (example: Meet EPACT)

The building is to meet the requirements of EPACT and other applicable executive orders.

What are the project goals and requirements for building siting that will impact energy use?

What are the project goals and requirements for building facade that will impact energy use?

High efficiency windows, roof and walls.

What are the project goals and requirements for building fenestration that will impact energy use?

Double-pane, low E windows.

What are the project goals and requirements for building envelope that will impact energy use?

The building is to be provided with a continuous air barrier.

What are the project goals and requirements for building roof that will impact energy use?

01 FEB 07

A white roof surface for a low-slope roof and a
light color roof surface for high-slope roofs.

Other: *(Insert as applicable)*

3. Indoor Environmental Quality Requirements

What is the intended use for all spaces? For all spaces that have an intended use that is not readily apparent from the space name, provide this information in Table 1.

Main use is a barracks. Supplemental uses are
laundry room, day-room, and computer room.

What is the anticipated occupancy schedule (numbers of occupants and time frames) for all occupied spaces? Indicate the default occupancy schedule below and for all spaces that have an occupancy schedule that differs from the default, provide this information in Table 1.

There will be two occupants per sleeping quarters
after normal working hours. This shall be the
default schedule.

What accommodations for after-hours use are required? (example: access control, lighting controls, HVAC controls) Indicate general accommodations required below and for all spaces that have special requirements, provide this information in Table 1.

Building is to be utilized 24/7.

What are the lighting, temperature, humidity, air quality, ventilation and filtration requirements for all spaces? Indicate the default requirements below and for all spaces that have a requirement that differs from the default, provide this information in Table 1.

Lighting: Lighting to be compliant with ASHRAE 90.1

Temperature: Temperature is to meet all UFC requirements.

Humidity: Humidity is to meet all UFC requirements.

Air Quality:

Ventilation: Ventilation to be compliant with ASHRAE 62.1.

Filtration: MERV-13 filters.

01 FEB 07

What are the acoustical requirements for all spaces? Indicate the default acoustical requirements below and for all spaces that have a requirement that differs from the default, provide this information in Table 1.

1. Sleeping quarters walls shall have an STC rating
_____ between 95 and 55. This shall be the default
_____ requirement.

What is the desired level of occupant ability to adjust systems controls? Indicate the default desired levels below and for all spaces that have a desired level that differs from the default, provide this information in Table 1.

Lighting: _____ Individual control per space.
Temperature: _____ Individual control per space.
Humidity: _____ Whole building control.
Air Quality: _____
Ventilation: _____ Whole building control.

What, if any, specific types of lighting are desired? (example: fluorescent in 2x2 grid, accent lighting, particular lamps)

_____ Fluorescent in 2x2 or 2x4 grid, indirect/direct
_____ fluorescent lighting.

4. Equipment and System Expectations

(Complete for each category as applicable or indicate "none identified" or "N/A". Add desired features information for other anticipated commissioned systems as applicable)

Indicate desired features for the following commissioned system: Space Heating

Desired Type: _____ None identified.
Quality: _____
Preferred Manufacturer: _____
Reliability: _____
Automation: _____
Flexibility: _____
Maintenance Requirements: _____
Efficiency Target: _____
Desired Technologies: _____

Indicate desired features for the following commissioned system: Ventilation

Desired Type: _____ None identified.

01 FEB 07

Quality: _____
Preferred Manufacturer: _____
Reliability: _____
Automation: _____
Flexibility: _____
Maintenance Requirements: _____
Efficiency Target: _____
Desired Technologies: _____

Indicate desired features for the following commissioned system: Air Conditioning

Desired Type: _____ None identified.
Quality: _____
Preferred Manufacturer: _____
Reliability: _____
Automation: _____
Flexibility: _____
Maintenance Requirements: _____
Efficiency Target: _____
Desired Technologies: _____

Indicate desired features for the following commissioned system: Refrigeration

Desired Type: _____ None identified.
Quality: _____
Preferred Manufacturer: _____
Reliability: _____
Automation: _____
Flexibility: _____
Maintenance Requirements: _____
Efficiency Target: _____
Desired Technologies: _____

Indicate desired features for the following commissioned system: HVAC Controls

Desired Type: _____ BACnet .
Quality: _____ ASHRAE 135 .
Preferred Manufacturer: _____ Johnson Controls .
Reliability: _____
Automation: _____ Fully automated .

01 FEB 07

Flexibility: _____ Fully compatible with the existing UMCS.
Maintenance Requirements: _____
Efficiency Target: _____
Desired Technologies: _____ BACnet .

Indicate desired features for the following commissioned system: Domestic Hot Water

Desired Type: _____ None identified.
Quality: _____
Preferred Manufacturer: _____
Reliability: _____
Automation: _____
Flexibility: _____
Maintenance Requirements: _____
Efficiency Target: _____
Desired Technologies: _____

Indicate desired features for the following commissioned system: Lighting Controls

Desired Type: _____ None identified.
Quality: _____
Preferred Manufacturer: _____
Reliability: _____
Automation: _____
Flexibility: _____
Maintenance Requirements: _____
Efficiency Target: _____
Desired Technologies: _____

Indicate desired features for the following commissioned system: Daylighting Controls

Desired Type: _____ None identified.
Quality: _____
Preferred Manufacturer: _____
Reliability: _____
Automation: _____
Flexibility: _____
Maintenance Requirements: _____
Efficiency Target: _____

01 FEB 07

Desired Technologies: _____

Indicate desired features for the following commissioned system: Emergency Power

Desired Type: _____ None identified.

Quality: _____

Preferred Manufacturer: _____

Reliability: _____

Automation: _____

Flexibility: _____

Maintenance Requirements: _____

Efficiency Target: _____

Desired Technologies: _____

Indicate desired features for the following commissioned system: Other - _____

Desired Type: _____

Quality: _____

Preferred Manufacturer: _____

Reliability: _____

Automation: _____

Flexibility: _____

Maintenance Requirements: _____

Efficiency Target: _____

Desired Technologies: _____

5. Building Occupant and O&M Personnel Requirements

How will the facility be operated? Who will operate the facility?

_____ The facility will be operated as a barracks
_____ facility. The facility will be operated by
_____ USAALS.

Will the facility be connected to an EMCS? If so, what are the interface requirements? (example: monitoring points, control points, scheduling)

_____ Yes. All requirements will be per all
_____ applicable UFC requirements.

01 FEB 07

What is the desired level of training and orientation for building occupants to understand and use the building systems?

Basic operation of all user systems.

What is the desired level of training and orientation for O&M staff to understand and maintain the building systems?

Maintenance staff to be fully trained on
operation and maintenance of building.

Table 1[illegible]

APPENDIX N
LEED Requirements for Multiple Contractor Combined Projects

Not Used



REQUEST FOR PROPOSAL



APPENDIX-O

LEED STRATEGY TABLES



LEED 2009 for New Construction and Major Renovation

Project Checklist

AIT Complex Phase I - Barracks / COF

30 Jun. 2010

17 3 Sustainable Sites Possible Points: 26

Y	N	?			
Y			Prereq 1	Construction Activity Pollution Prevention	
1			Credit 1	Site Selection	1
5			Credit 2	Development Density and Community Connectivity	5
	N		Credit 3	Brownfield Redevelopment	1
6			Credit 4.1	Alternative Transportation—Public Transportation Access	6
1			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
	N		Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
	N		Credit 4.4	Alternative Transportation—Parking Capacity	2
1			Credit 5.1	Site Development—Protect or Restore Habitat	1
1			Credit 5.2	Site Development—Maximize Open Space	1
1			Credit 6.1	Stormwater Design—Quantity Control	1
1			Credit 6.2	Stormwater Design—Quality Control	1
		1	Credit 7.1	Heat Island Effect—Non-roof	1
		1	Credit 7.2	Heat Island Effect—Roof	1
		1	Credit 8	Light Pollution Reduction	1

6 2 Water Efficiency Possible Points: 10

Y	N	?			
Y			Prereq 1	Water Use Reduction—20% Reduction	
4			Credit 1	Water Efficient Landscaping	2 to 4
	N		Credit 2	Innovative Wastewater Technologies	2
2		2	Credit 3	Water Use Reduction	2 to 4

12 8 Energy and Atmosphere Possible Points: 35

Y	N	?			
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
5		8	Credit 1	Optimize Energy Performance	1 to 19
	N		Credit 2	On-Site Renewable Energy	1 to 7
2			Credit 3	Enhanced Commissioning	2
2			Credit 4	Enhanced Refrigerant Management	2
3			Credit 5	Measurement and Verification	3
	N		Credit 6	Green Power	2

3 6 Materials and Resources Possible Points: 14

Y	N	?			
Y			Prereq 1	Storage and Collection of Recyclables	
	N		Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
	N		Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
1		1	Credit 2	Construction Waste Management	1 to 2
		1	Credit 3	Materials Reuse	1 to 2

Materials and Resources, Continued

Y	N	?			
1		1	Credit 4	Recycled Content	1 to 2
1		1	Credit 5	Regional Materials	1 to 2
		1	Credit 6	Rapidly Renewable Materials	1
		1	Credit 7	Certified Wood	1

8 5 Indoor Environmental Quality Possible Points: 15

Y	N	?			
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Outdoor Air Delivery Monitoring	1
		1	Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
		1	Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
		1	Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
1			Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems—Lighting	1
		1	Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			Credit 7.1	Thermal Comfort—Design	1
		1	Credit 7.2	Thermal Comfort—Verification	1
	N		Credit 8.1	Daylight and Views—Daylight	1
	N		Credit 8.2	Daylight and Views—Views	1

1 Innovation and Design Process Possible Points: 6

Y	N	?			
			Credit 1.1	Innovation in Design: Specific Title	1
			Credit 1.2	Innovation in Design: Specific Title	1
			Credit 1.3	Innovation in Design: Specific Title	1
			Credit 1.4	Innovation in Design: Specific Title	1
			Credit 1.5	Innovation in Design: Specific Title	1
1			Credit 2	LEED Accredited Professional	1

Regional Priority Credits Possible Points: 4

Y	N	?			
			Credit 1.1	Regional Priority: Specific Credit	1
			Credit 1.2	Regional Priority: Specific Credit	1
			Credit 1.3	Regional Priority: Specific Credit	1
			Credit 1.4	Regional Priority: Specific Credit	1

47 24 Total Possible Points: 110

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

APPENDIX P

LEED Registration of Army Projects

15 April 2010

Number of Registrations

Each building must be registered separately, except multiple instances of a standard building on a shared site may be registered as a single project. If a single registration for multiple buildings is chosen, all buildings under the single registration must earn exactly the same points. Do not register buildings that are exempt from a specific LEED achievement requirement.

Typical Registration Procedure

1. Login, complete the online registration form (see guidance below) at the GBCI LEED Online website <http://www.gbci.org/DisplayPage.aspx?CMSPageID=174> and submit it online.
2. Pay the registration fee via credit card (USACE staff: credit card PR&C is funded by project design or S&A funds).
3. GBCI will follow up with a final invoice, the LEED-online passwords and template information.
4. The individual who registers the project online is, by default, the Project Administrator.

Completing the Registration Form

BEFORE YOU BEGIN:

Create a personal account with USGBC if you do not have one.

You will need the following information:

Project name as it appears in P2 (obtain from USACE Project Manager)

Building number/physical address of project

Zip code for Installation/project location

Anticipated construction start and end dates

Total gross area all non-exempt buildings in registration

Total construction cost all non-exempt buildings only (see Project Details Section instructions below)

ACCOUNT/LOGIN INFORMATION

1. The person registering the project **must have an account with USGBC** (login and password) to complete the form. Go to <http://www.gbci.org/>, click on "register a project" at the drop-down menu for project certification (at the top of the page) and select "register now for LEED 2009" to start the project registration process. If you have an account, login with your email address and password and select "register new project" to proceed. If you do not have an account, you may select "register a new account" and follow the instructions. It is recommended that you create an account separately on the USGBC website before you start the form. IMPORTANT: USACE team members are members of USGBC and are eligible for Member prices. USACE team members registering projects should be sure to include the USACE Corporate Access ID in their personal account profile (if you do not have it contact richard.l.schneider@usace.army.mil or judith.f.milton@usace.army.mil for the number).
2. The Account/Login Information section is filled out by the person registering the project. It may be a Contractor or a USACE staff member.

ELIGIBILITY SECTION

Follow directions (accepting the terms and conditions)

Review your profile information and make corrections if needed

RATING SYSTEM SELECTION SECTION

Select single project registration and I know which rating system.

Select the rating system - currently only LEED-NC and LEED for Homes are approved for Army use without special approval.

LEED Minimum Program Requirements: select YES

Friday, July 23, 2010

RATING SYSTEM RESULTS SECTION

Confirm selected rating system.

PROJECT INFORMATION SECTION

Project Title: Begin the project title with a one-word identifier for the Installation. Do not include the word "Fort". After this match the project name used in P2 (contact the USACE Project Manager for this information) and identify the building being registered. Example: "Stewart 4th IBC - DFAC".

Project Address 1 and 2: This is the physical location of the project. Provide building number, street address, block number or whatever is known to best describe the location of the project on the Installation.

Project City: Installation Name

State, Country, Zip Code: Self-explanatory

Anticipated Construction Start and End Dates: Self-explanatory – give your best guess if unknown. Note that required data entry format is: 1 or 2 digit month/1 or 2 digit date/4 digit year (example 3/23/2010)

Gross Square Footage: Provide total area all buildings in LEED project. Exclude the area of any buildings that are exempt from the LEED achievement requirement (for example, exclude an unconditioned storage shed to be constructed with a barracks complex).

Is Project Confidential: Indicate NO except, if project has security sensitivity (elements that are FOUO or higher security), indicate YES.

Notification of Local Chapter: Indicate NO unless Government/USACE Project Manager requests you to indicate YES.

Anticipated Project Type: Select the most appropriate option from the drop-down menu.

Anticipated Certification Level: Select the applicable option from the drop-down menu (Silver is the usual level).

PROJECT OWNER INFORMATION SECTION

Project Owner First Name, Last Name, email, phone, address: The Project Owner is the USACE Project Manager. Obtain this info from the USACE Project Manager.

Organization: U.S. Army Corps of Engineers. This field MUST be completed this way because it will be used as a search field by higher HQ to find all USACE registered projects. You may supplement it with district name at the end but DO NOT revise or use an acronym.

May we publish Owner information: Indicate NO

Owner Type: Pick Federal Government from drop-down menu.

Project Owner Assertion: Check the box

PAYMENT INFORMATION

Self-explanatory

APPENDIX Q
REV 1.1 – 31 MAY 2009
AREA COMPUTATIONS

Computation of Areas: Compute the "gross area" and "net area" of facilities (excluding family housing) in accordance with the following subparagraphs:

(1) Enclosed Spaces: The "gross area" is the sum of all floor spaces with an average clear height $\geq 6'-11"$ (as measured to the underside of the structural system) and having perimeter walls which are $\geq 4'-11"$. The area is calculated by measuring to the exterior dimensions of surfaces and walls.

(2) Half-Scope Spaces: Areas of the following spaces shall count as one-half scope when calculating "gross area":

- Balconies
- Porches
- Covered exterior loading platforms or facilities
- Covered but not enclosed passageways and walks
- Open stairways (both covered and uncovered)
- Covered ramps
- Interior corridors (Unaccompanied Enlisted Personnel Housing Only)

(3) Excluded Spaces: The following spaces shall be excluded from the "gross area" calculation:

- Crawl spaces
- Uncovered exterior loading platforms or facilities
- Exterior insulation applied to existing buildings
- Open courtyards
- Open paved terraces
- Uncovered ramps
- Uncovered stoops
- Utility tunnels and raceways
- Roof overhangs and soffits measuring less than 3'-0" from the exterior face of the building to the fascia

(4) Net Floor Area: Where required, "net area" is calculated by measuring the inside clear dimensions from the finish surfaces of walls. If required, overall "assignable net area" is determined by subtracting the following spaces from the "gross area":

- Basements not suited as office, special mechanical, or storage space
- Elevator shafts and machinery space
- Exterior walls
- Interior partitions
- Mechanical equipment and water supply equipment space
- Permanent corridors and hallways
- Stairs and stair towers
- Janitor closets
- Electrical equipment space
- Electronic/communications equipment space

RMS SUBMITTAL REGISTER INPUT FORM			CONTRACT NUMBER		DELIVERY ORDER																				
TITLE AND LOCATION																									
Button	<-----Right click for Instructions		TYPE OF SUBMITTAL								CLASSIFICATION				REVIEWING OFFICE										
SECTION	PARAGRAPH NUMBER	DESCRIPTION OF ITEM SUBMITTED	01 - PRECON SUBMITTALS	02 - SHOP DRAWINGS	03 - PRODUCT DATA	04 - SAMPLES	05 - DESIGN DATA	06 - TEST REPORTS	07 - CERTIFICATES	08 - MFRS INSTRUCTIONS	09 - MFRS FIELD REPORT	10 - O&M DATA	11 - CLOSEOUT SUBMITTALS	FO - FOR INFORMATION ONLY	GA - GOVERNMENT APPROVED	DA - DESIGNER OF RECORD APPROVAL	CR - CONFORMANCE REVIEW	DA / CR	DA / GA	DO - DISTRICT OFFICE	AO - AREA OFFICE	RO - RESIDENT OFFICE	PO - PROJECT OFFICE	DR - DESIGNER OF RECORD	AE - ARCHITECT / ENGINEER
00 72 00	52.236-13	Accident Prevention Plan	X													X				X					
00 73 00	1.11	Dev. From Accept. Design. No Deviation from Contract					X										X			X				X	
00 73 00	1.11	Dev. From Accepted Design - Deviates from Contract					X											X		X				X	
00 73 00	1.17	Supplemental Price Breakdown	X											X						X					
00 73 00	1.18	SSHO Qualifications	X											X						X					
01 10 00	5.2.3.1	(if concrete pavement) Joint Layout Plan with design drawings					X							X		X				X					
01 10 00	5.5.2	Building Envelope Sealing Performance Testing						X						X						X					
01 10 10	***	Tests as Req by Codes - DOR Develops Test Program						X						X						X				X	
01 10 00	5.8.3	BAS Review Information		X										X						X	X			X	
01 10 00	5.8.3	BAS Performance Verification Test						X						X						X	X			X	
01 10 00	5.8.4	Testing Adjusting and Balancing						X						X						X				X	
01 10 00	5.8.5	Commissioning						X						X						X				X	
01 10 00	6.15	Environmental As Required for Site Specific					X									X				X	X			X	
01 10 00	6.16	Permits as required for Site specific					X									X				X				X	
01 10 00	5.10.2	Fire Protection Tests						X	X					X						X				X	
01 32 01.00 10	3.4.1	Preliminary Project Schedule	X											X						X					
01 32 01.00 10	3.4.2	Initial Project Schedule	X											X						X					
01 32 01.00 10	3.4.3	Design Package Schedule	X											X						X					
01 32 01.00 10	3.6.1	Periodic schedule updates from the Contractor	X											X						X					
01 32 01.00 10	3.7	Time Extension Request (Schedule)	X											X						X					
01 33 00	1.8	Submittal Register - DOR Input Required	X											X						X				X	
01 33 00	1.8	Submittal Register Updates (Design Packages, etc.)	X											X						X				X	
01 33 00	1.3.1	Substitution of Manuf or Model Named in Proposal		X	X									X						X				X	
01 33 16	1.2	Identify Designer(s) of Record	X											X						X				X	
01 33 16	1.1.2 / 3.2.4	Fast Track Design Package(s)					X									X			X	X					
01 33 16	1.2	Identification of all Designers of Record	X													X				X					
01 33 16	3.2.1	Site and Utility Des Package, incl. Substantiation					X									X			X	X					
01 33 16	3.2.2/3.5	Interim Des Subm Package(s), incl. Substantiation					X									X			X	X					
01 33 16	3.5.1	Drawings					X									X			X	X					
01 33 16	3.5.2.2	Sitework Design Analyses					X									X			X	X					
01 33 16	3.5.2.3	Structural Design Analyses					X									X			X	X					
01 33 16	3.5.2.4	Security Design Analyses					X									X			X	X					
01 33 16	3.5.2.5	Architectural Design Analyses					X									X			X	X					
01 33 16	3.5.2.6	Mechanical Design Analyses					X									X			X	X					
01 33 16	3.5.2.7	Life Safety Design Analyses					X									X			X	X					
01 33 16	3.5.2.8	Plumbing Design Analyses					X									X			X	X					
01 33 16	3.5.2.9	Elevator Design Analyses (as Applicable)					X									X			X	X					
01 33 16	3.5.2.10	Electrical Design Analyses					X									X			X	X					
01 33 16	3.5.2.11	Telecommunications Design Analyses					X									X			X	X					
01 33 16	3.5.2.12	Cathodic Protection Design Analyses					X									X			X	X					
01 33 16	3.5.3	Geotechnical Investigations and Reports					X									X			X	X					
01 33 16	3.5.4	LEED Submittals					X									X			X	X					
01 33 16	3.5.5	Energy Conservation Documentation					X									X			X	X					
01 33 16	3.5.6	Specifications					X									X			X	X					
01 33 16	3.5.7	Building Rendering					X									X			X	X					
01 33 16	3.2.4/3.7	Final Des Submittal Package(s), incl. Substantiation					X									X			X	X					
01 33 16	3.7.5	DD Form 1354 (Transfer of Real Property)										X				X			X						
01 33 16	3.2.5/3.8	Design Complete Submittal Package(s)					X									X			X	X					
01 33 16	3.3.3	Design and Code Review Checklists					X									X			X	X					
01 33 16	A-2.0	SID - Interim and Final (as applicable)			X	X	X							X					X						
01 33 16	B-2.0	FFE (as Applicable)					X							X					X						
01 45 04.00 10	3.2	Design and Construction QC Plan	X													X			X						
01 57 20.00 10	1.2	Environmental Protection Plan	X													X			X						
01 78 02.00 10	1.2.1	Final as-Built Drawings										X		X					X						
01 78 02.00 10	1.2.3.11	Non-Hazardous Solid Waste Diversion Reports						X						X					X						
01 78 02.00 10	1.2.7	Provide final as-built CADD and BIM Model files										X		X					X						
01 78 02.00 10	1.2.9	Provide scans of all other docs in Adobe.pdf format										X		X					X						
01 78 02.00 10	1.3.1	Equip-in-Place list of all installed equip and cost										X		X					X						
01 78 02.00 10	1.3.2	Data on equip not addressed in O&M manuals										X		X					X						
01 78 02.00 10	1.3.3	Final as-built specs - electronic files										X		X					X						
01 78 02.00 10	1.4.2.1	Warranty management plan - FAR 52.246-21										X		X					X						
01 78 02.00 10	1.4.2.1	Certificates of Warranty for extended warranty items										X		X					X						
01 78 02.00 10	1.4.2.1	Contractor's POCs for implementing warranty process										X		X					X						
01 78 02.00 10	1.4.2.1	List of each warranted equip, item, feature or system										X		X					X						
01 78 02.00 10	1.5	See also Section 01 10 00 par. 5.8.4 and 5.8.5										X		X					X						
01 78 02.00 10	1.6.1.2	Equipment O&M Manuals - 1 electronic / 2 hard copies										X		X					X						
01 78 02.00 10	1.7	Field Training DVD Videos									X			X					X						
01 78 02.00 10	1.8	Pricing of CF/CI and GF/CI Property										X		X					X						
01 78 02.00 10	1.11	List of Completed Cleanup Items										X				X			X						



REQUEST FOR PROPOSAL



APPENDIX-AA

FORT EUSTIS, DPW STANDARD OPERATING PROCEDURES

**Department of the Army
US Army Transportation Center
Fort Eustis, Virginia 23604-5306**

**Standard Operating Procedure, DPW
Operations, Maintenance, and Construction
Processing Water Distribution and Wastewater Collection Work Requests**

- 1. PURPOSE:** To establish a standard operating procedure for processing water and wastewater system work requests.
- 2. SCOPE:** This procedure applies to all Divisions within the Directorate of Public Works (DPW) at Fort Eustis, the DPW office at Fort Story, and to all activities at both Army installations.
- 3. REFERENCES:**
 - a. Defense Energy Support Center Utilities Privatization TRADOC Virginia Installations, Solicitation No. SP0600-01-R-0047
 - b. Ownership, Operation, and Maintenance of the Water Distribution and Wastewater Collection Systems (Privatization), at Fort Eustis, Fort Story, and Fort Monroe, Virginia: Contract SP0600-05-C-8252 with Old Dominion Utility Services, dated 29 September 2005 and all subsequent modifications.
- 4. POLICIES:**
 - a. Old Dominion Utility Services (ODUS) has obtained full ownership of all water distribution and wastewater collection facilities at Fort Eustis and Fort Story. All water and wastewater system work up to the points of contractual demarcation is to be done by ODUS and its designated contractors.
 - b. The design and construction of modifications to existing water or wastewater facilities is to be done by ODUS. A request for a modification to the ODUS standard design can be submitted at requester's additional expense.
 - c. All work for the installation of Sanitary Sewer or Potable Water will be performed by Old Dominion Utility Services, Inc., (ODUS) up to the 5' demarcation line of the building, including abandonment and filling of existing sanitary sewers and manholes. ODUS will provide all sanitary sewer lines, two way cleanouts manholes and connection to manholes and other apparatus as required. The CONTRACTOR will make the final connection from the building to the 5' line of demarcation. ODUS will install all water lines and associated valves, hydrants, meters and associated apparatus to within 5' foot of the building line, a cut-off valve or meter will be used at the 5' line of demarcation.

Operations, Maintenance, and Construction
Processing Water Distribution and Wastewater Collection Work Requests

d. ODUS will provide all engineering, design, material procurement, and construction of alterations and modification to the water and wastewater facilities as necessary to meet Fort Eustis's and Fort Story's water and wastewater service requirements.

e. All requests for new, disconnection, or upgraded water and wastewater service should be coordinated directly with ODUS, through Larry Malcom at 757-888-0485 or email to lmalcom@odus.asusinc.com.

5. PROCEDURES: The Directorate of Public Works at Fort Eustis will assist in supporting activities coming to or residing on Fort Eustis and Fort Story with engineering support. The execution of water and wastewater system work is improved with proper project planning. The following procedures are provided to help facilitate water and wastewater service and construction support with recommendations and Points of Contract (P.O.C.).

a. Incorporating into design specification or Statements of Work (SOW) that – *“Old Dominion Utility Services will provide all engineering, design, material procurement, and construction of water distribution and wastewater collection facilities necessary to meet Fort Eustis' and Fort Story's water and wastewater service requirements.”*

b. Specifications for special requirements should be communicated to ODUS, Larry Malcom, as early as known in project development.

c. Submission of required Request for Proposal (RFP) letter is to be done electronically. The completed letter is to be e-mailed to the Contracting Officers Representative (COR).

d. Electronic version of the RFP letter is available on the Public drive: DPW Public/DPW Forms/Old Dominion Utility Services

e. Contracting Officer's Representative (COR) on this contract is Daniel Wood, 757-878-2489 ext. 228, e-mail Daniel.benito.wood@us.army.mil.

6. REQUESTING WATER AND WASTEWATER WORK:

a. Requesting Water and Wastewater Service Connection(s): The procedure for requesting a service connection to a temporary trailer, building under renovation, or newly constructed facility requires the following items be done.

(1) Obtain Site approval from Fort Eustis' Master Planning.

(2) Electronically submit water and wastewater system work RFP form letter (Exhibit A) to COR, Daniel Wood, email Daniel.benito.wood@us.army.mil. Exhibit A, with instructions in parentheses, is attached.

(3) Establish utility account with the Fort Eustis Utilities Sales Officer, 757-878-2509.

**Operations, Maintenance, and Construction
Processing Water Distribution and Wastewater Collection Work Requests**

b. Requesting Water and Wastewater Service Disconnection(s):

(1) Electronically submit completed water and wastewater system work RFP form letter (Exhibit A) to COR, Daniel Wood, Daniel.benito.wood@us.army.mil.

(2) Notify Fort Eustis' Utilities Sales Officer, 757-878-2509 of termination in service request.

c. Requesting Water and Wastewater System Modifications:

Electronically submit completed water and wastewater system work RFP form letter (Exhibit A) to COR, Daniel Wood, Daniel.benito.wood@us.army.mil.

7. PROJECT FUNDING:

a. The funding for electrical distribution system work (design, contract administration, and service installation) is funded by each individual project. Fort Eustis and Fort Story Army installations do not maintain an account to fund specific projects, connection fees, or disconnection fees.

b. The Point of Contact for processing OMA, interagency MIPR, and non-governmental funding for water and wastewater system work projects is the Utilities Sales Officer, 757-878-2509.


E. TRENT SPENCER
Director of Public Works

**Operations, Maintenance, and Construction
Processing Water Distribution and Wastewater Collection Work Requests**

EXHIBIT A

REQUEST for PROPOSAL - WATER/WASTEWATER UTILITY WORK

Old Dominion Utility Services - Contract # SP0600-05-C-8252

Date: (Current Date)

SUBJECT: Request for Proposal

Project Manager: (Name, Phone Number)

1. We request that your firm submit a fee proposal for the following project

- a. Title: (Project Title: Description of Scope of Work)
- b. Individual Job Order Number: (If applicable)
- c. Location: (Address or description of location with distance from landmarks or site map)
- d. Scope of work stated above was discussed at the site with the following people:
(List names, Organizations, and phone numbers of people at site visit)

2. Proposal Due Date: (Submit date required – Recommend at least 2-4 weeks from date of submission)

3. Disclaimer:

a. You are advised that this letter is not to be construed as authority to proceed with any work or to incur any obligations chargeable to the Government SAF.

b. Further, in the event of unsatisfactory fee negotiations, the Government can not assume any obligation for payment of any expense incurred by your firm in the preparation of your fee or premature initiation of services.

4. Attachments:

a. Site visit Task Order Scope of Work: Work was discussed and understood on a walk-through by (List names, organizations, and phone numbers.).

**Department of the Army
US Army Transportation Center
Fort Eustis, Virginia 23604-5306**

**Standard Operating Procedure, DPW
Operations, Maintenance, and Construction
Processing Electrical Distribution System Work Requests**

- 1. PURPOSE:** To establish a standard operating procedure for processing electrical distribution system work requests.
- 2. SCOPE:** This procedure applies to all Divisions within the Directorate of Public Works (DPW) at Fort Eustis, the DPW office at Fort Story, and to all activities at both Army installations.
- 3. REFERENCES:**
 - a. Defense Energy Support Center Utilities Privatization TRADOC Virginia Installations, Solicitation No. SP0600-01-R-0047
 - b. Ownership, Operation, and Maintenance of the Electrical Distribution Systems (Privatization), at Fort Eustis, Fort Story, and Fort Monroe, Virginia. Contract SP0600-04-C-8253 with Dominion Virginia Power, dated 24 June 2004 and all subsequent modifications.
- 4. POLICIES:**
 - a. Dominion has obtained full ownership of all overhead and underground electrical distribution facilities, including the area and roadway lighting facilities that are served directly from the distribution system. All electrical distribution system work up to the point of contractual demarcation (i.e. meter base, primary side of transformer, etc.) is to be done by Dominion Virginia Power and its designated contractors.
 - b. The design of electrical distribution system wiring, layout, and equipment selection is to be done by Dominion Virginia Power. A request for a modification to the Dominion Virginia Power standard design can be submitted at requester's additional expense.
 - c. Dominion will provide all engineering, design, material procurement, and construction of electrical distribution facilities necessary to meet Fort Eustis's and Fort Story's electric service requirements. This responsibility includes primary and secondary conductors to existing and new buildings with few exceptions.
 - d. All requests for new, disconnection, or upgraded electric service should be coordinated directly with Dominion, through Steve Buell at 757-434-6195 (Office/Cellular), 757-857-2892 (Pager) or email to steve.buell@dom.com.

**Operations, Maintenance, and Construction
Processing Electrical Distribution System Work Requests**

c. New construction should conform to Dominion's standards as stated in the "Information and Requirements for Electric Service". This document can be found at website, www.dom.com, by typing "blue book" in the search box.

5. PROCEDURES: The Directorate of Public Works at Fort Eustis will assist in supporting activities coming to or residing on Fort Eustis and Fort Story with engineering support in a timely manner. The execution of electrical distribution system work is improved with proper project planning. The following procedures are provided to help facilitate electrical distribution service and construction support with recommendations and Points of Contract (P.O.C.).

a. Incorporating into design specification or Statements of Work (SOW) that - *Dominion Virginia Power will provide all engineering, design, material procurement, and construction of electrical distribution facilities necessary to meet Fort Eustis' and Fort Story's electric service requirements. This responsibility includes primary and secondary conductors to existing and new buildings with few exceptions.*

b. Specifications for special requirements (i.e. underground service drop, transfer switch installation, additional future capacity, etc.) should be communicated to Dominion, Steve Buell, as early as known in project development.

c. Submission of required forms, exhibit A and/or exhibit B, is to be done electronically. Each form is to be e-mailed to the Contracting Officers Representative (COR).

d. See paragraph 8. below for information on obtaining copies of exhibit A and exhibit B.

e. Contracting Officer's Representative (COR) on this electric utility privatization contract is Daniel Wood, 757-878-2489 ext. 228, e-mail daniel.benito.wood@us.army.mil.

6. REQUESTING ELECTRICAL DISTRIBUTION WORK:

a. Requesting Electrical Service Connection(s): The procedure for requesting a service connection to a temporary trailer, building under renovation, or newly constructed facility requires the following items be done.

(1) Electronically submit Dominion Virginia Power Load letter (exhibit A) to COR, Daniel Wood, email daniel.benito.wood@us.army.mil.

(2) Obtain Site approval from Fort Eustis' Master Planning.

(3) Electronically submit electrical distribution system work Request for Proposal form (exhibit B) to COR, Daniel Wood, email daniel.benito.wood@us.army.mil.

(4) Establish utility account with Fort Eustis' Utilities Sales Officer, 757-878-2509.

b. Requesting Electrical Service Disconnection(s):

**Operations, Maintenance, and Construction
Processing Electrical Distribution System Work Requests**

(1) Electronically submit electrical distribution system work Request for Proposal form (exhibit B) to COR, Daniel Wood, daniel.benito.wood@us.army.mil.

(2) Notify Fort Eustis' Utilities Sales Officer, Cathy Ferguson, 757-878-2509 of termination in service request.

c. Requesting Electrical Distribution System Modification: Electronically submit electrical distribution system work Request for Proposal form (exhibit B) to COR, Daniel Wood, daniel.benito.wood@us.army.mil.

7. PROJECT FUNDING:


a. The funding for electrical distribution system work (design, contract administration, and service installation) is funded by each individual project. Fort Eustis and Fort Story Army installations do not maintain an account to fund specific projects, connection fees, or disconnection fees.

b. The Point of Contact for processing OMA, interagency MIPR, and non-governmental funding for electrical distribution system work projects is the Utilities Sales Officer, 757-878-2509.

8. EXHIBITS:

a. Exhibit A, Load Letter, is a form that, when completed, describes electric service requirements for new or renovated facilities. Dominion Virginia Power uses this completed form to determine what service will be necessary to support the new or renovated facility. Exhibit A is available on the Public drive: DPW Public/DPW Forms//DVP DOCs

b. Exhibit B is a form letter that is to be used to request a proposal from Dominion Virginia Power for electric utility work. Exhibit B sample is attached. Instructions are in parentheses. Electronic version of the RFP letter is available on the Public drive: DPW Public/DPW Forms/DVP DOCs.



E. TRENT SPENCER
Director of Public Works

**Dominion**

The use of "Dominion" on this form refers to Dominion Virginia Power and Dominion North Carolina Power

EXHIBIT A Load Letter

General Information																																												
Service Location (Street Address)			Type of Business																																									
Electrician	Address		Phone																																									
Customer	Address		Phone																																									
Total Square Footage	Conditioned Space Square Footage	Type of Heat																																										
Similar Account Information (Buildings of like types of business, square footage, operating hours and heating type)																																												
Name of Similar Business	Address of Similar Business	(Dominion) Similar Account Number(s)																																										
Type of Service (Check all that apply)																																												
<input type="checkbox"/> Underground		<input type="checkbox"/> Service Change (Rewire)		<input type="checkbox"/> New																																								
<input type="checkbox"/> Overhead		<input type="checkbox"/> Relocation		<input type="checkbox"/> Temporary																																								
Service Characteristics																																												
Size of Load Wires:	Sets of Load Wires Per Phase:	Load Wire Type: <input checked="" type="checkbox"/> AL <input type="checkbox"/> CU																																										
Terminations: <input checked="" type="checkbox"/> Meterbase <input type="checkbox"/> Connection Box <input type="checkbox"/> C.T. Cabinet <input type="checkbox"/> Switchgear/Manf. # <input type="checkbox"/> Other:																																												
Service Size																																												
<input checked="" type="checkbox"/> 100 amp <input type="checkbox"/> 150 amp <input type="checkbox"/> 200 amp <input type="checkbox"/> 300 amp <input type="checkbox"/> 400 amp <input type="checkbox"/> 600 amp <input type="checkbox"/> Other:																																												
Voltage																																												
<input checked="" type="checkbox"/> 1 Phase, 3 Wire, 120/240		<input type="checkbox"/> 3 Phase, 4 Wire, Delta, 120/240 (Limited to 200 amps or less per service connection)																																										
<input type="checkbox"/> 3 Phase, 4 Wire, Wye, 120/208		<input type="checkbox"/> 3 Phase, 4 Wire, Wye, 277/480 <input type="checkbox"/> Other (Must be approved by Dominion)																																										
Electric Load (Excluding Motor Load)			Electric Motor Load (Except Heating and AC)																																									
Interior Lighting	kw	Computers	kw	<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th>Phase</th> <th>Number of Motors</th> <th>HP</th> <th>Voltage</th> <th>Hours of Operation Per Week</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table>	Phase	Number of Motors	HP	Voltage	Hours of Operation Per Week																																			
Phase	Number of Motors	HP	Voltage		Hours of Operation Per Week																																							
Exterior Lighting	kw	Receptacles	kw																																									
Electric Cooking	kw	Refrigeration	kw																																									
Water Heating	kw	Other	kw																																									
Dryer	kw	Other	kw																																									
Heat Pump	kw	Other	kw																																									
Heat Pump Strip Heat	kw	**Future	kw																																									
Electric Heat (Baseboard or Furnace)	kw																																											
AC (Data Processing Load Only)	tons																																											
AC (Not Including Data Processing)	tons																																											
Estimated Business Operating Time				*Meter Location Desired																																								
Hours Per Week:		Months Per Year:		<input checked="" type="checkbox"/> Indoor <input type="checkbox"/> Outdoor																																								
Load Management Device				*Service Equipment Location Desired																																								
<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No If Yes, setting:				<input checked="" type="checkbox"/> Indoor <input type="checkbox"/> Outdoor																																								

The Information provided in this document, by the customer, is critical to Dominion in sizing our electrical facilities to provide reliable service to you. This information will also be used to determine the installation cost for electrical service.

All conductors must enter from top and bottom (not side or back) of the instrument transformer cabinet. Line and load conductors must enter from opposite ends of the cabinet so that metered and non-metered conductors will not cross.

*The company reserves the right to designate and/or approve the location of all metering and C.T. equipment. The company must approve all proposed metering arrangements.

**The customer must notify Dominion prior to the actual connection of any future load (as required by Information and Requirements for Electric Service *The Blue Book*).

Signature	Date
-----------	------

Distribution: Please forward this form to Dominion's project designer. If the project designer is unknown, forward to customer_service @ dom.com or call 1-888-667-3000

Form No. 725071(Nov 2004)
© 2004 Dominion Resources Services, Inc.

Friday, July 23, 2010

Instructions for EXHIBIT A

Instructions for Completing the Load Letter (Form No. 720571)

General Information

Service Location (Physical Location)	Street Address, City & State of building being served.
Type of Business	Type of business being served (i.e. Restaurant, office, etc.).
Electrician, Address, Phone	Name, address, and phone number of the electrician performing new work on this building.
Customer, Address, Phone	Name of the ultimate customer along with their present address and phone number.
Total Square Footage	Total floor space of building.
Conditioned Space Square Footage	Floor space of the building subject to heating and cooling.
Type of Heat	Electric, Gas, Propane, Oil, Other (please specify)

Similar Account Information (Buildings of like square footage and heating type)

Name of Similar Business	Name of similar business (must be similar size and heating type).
Address of Similar Business	Physical address of similar business (must be similar size and heating type).
(Dominion) Similar Account Number(s)	Dominion account number (if known) of the similar business (list several if possible — must be similar size and heating type).

Type of Service (Check all that Apply)

Check all that apply to the new service being provided.

Service Characteristics

Load Wires	Include conductor size, number of sets, and type of load conductors.
Terminations	Indicate where the customer's conductors and Dominion conductors will terminate together. If in a switchgear, please provide the specific number and manufacturer of the gear.

Service Size

Check the size of your panel or switchgear.

Voltage

Check the voltage that you want delivered to the building.

Electrical Load (Excluding Motor Load)

List all non-motor electrical loads at this location in terms of kw and tons

Electrical Motor Load (Except Heating and AC)

List all of the motors that will be used at this location along with the number of motors, horsepower, voltage, and hours of operation per week (except Heating and AC).

Load Management Device

If you are limiting the kw demand to a certain level with an automated device, check "Yes." If "Yes", enter the maximum kw setting of the device.

Estimated Business Operating Time

Hours Per Week	Enter how many hours per week the business will be in operation.
Months Per Year	Enter how many months per year the business will be in operation.

Meter Location Desired

Check the location you prefer for the meter (subject to Dominion approval).

Service Equipment Location Desired

Check the location you prefer for the service equipment (subject to Dominion approval).

**Operations, Maintenance, and Construction
Processing Electrical Distribution System Work Requests**

EXHIBIT B

REQUEST for PROPOSAL – ELECTRIC UTILITY WORK

Dominion Virginia Power - Contract # SP0600-04-C-8253

Date: (Current Date)

SUBJECT: Request for Proposal

Project Manager: (Name, Phone Number)

1. We request that your firm submit a fee proposal for the following project
 - a. Title: (Project Title: Description of Scope of Work)
 - b. Individual Job Order Number: (If applicable)
 - c. Location: (Address or Description of location with distance from landmarks or site map)
 - d. Scope of work stated above was discussed at the site with the following people: (List names, Organizations, and phone numbers of people at site visit)
2. Proposal Due Date: (Submit date required – Recommend at least 2-4 weeks from date of submission)
3. Disclaimer:
 - a. You are advised that this letter is not to be construed as authority to proceed with any work or to incur any obligations chargeable to the Government SAF.
 - b. Further, in the event of unsatisfactory fee negotiations, the Government can not assume any obligation for payment of any expense incurred by our firm in the preparation of your fee or premature initiation of services.
4. Attachments:
 - a. Site visit Task Order Scope of Work: Work was understood on a walk through by (List names, organizations, and phone numbers).

Department of the Army
US Army Transportation Center
Fort Eustis, Virginia 23604-5306

**Standard Operating Procedure, DPW
Operations, Maintenance, and Construction
Processing Natural Gas Distribution Service Work Requests**

- 1. PURPOSE:** To establish a procedure for processing natural gas distribution system work requests.
- 2. SCOPE:** This procedure applies to all Divisions within the Directorate of Public Works (DPW) at Fort Eustis, the DPW office at Fort Story, and to all activities at both Army installations.
- 3. REFERENCE:** NRCC Contract Number GS00P02BSD0181 with Virginia Natural Gas, Inc., Natural Gas Supplies and Services for Fort Eustis and Fort Story
- 4. POLICIES:**
 - a. Virginia Natural Gas owns and operates all natural gas distribution facilities at Fort Eustis and Fort Story. All natural gas distribution system work, on new and existing natural gas piping, up to the downstream side of the meter and regulator at the facility being served is done by Virginia Natural Gas or its designated contractors.
 - b. Virginia Natural Gas will provide all engineering, design, material procurement, and construction of alterations and modification to the natural gas facilities as necessary to meet Fort Eustis's and Fort Story's natural gas service requirements.
 - c. All requests for new, disconnection, or upgraded natural gas service should be coordinated directly with Virginia Natural Gas, through Heath Deaver at 757-455-5361 or email to rdeaver@aglresources.com.
- 5. PROCEDURES:** The Directorate of Public Works at Fort Eustis will assist in supporting activities coming to or residing on Fort Eustis and Fort Story with engineering support. The execution of natural gas service work is improved with proper project planning. The following procedures are provided to help facilitate natural gas service and construction support with recommendations and Points of Contract (P.O.C.).
 - a. Incorporating into design specification or Statements of Work (SOW) that –
“Virginia Natural Gas, Inc., will provide all engineering, design, material procurement, and construction of natural gas facilities necessary to meet Fort Eustis' and Fort Story's natural gas service requirements.”

Section:
Operations, Maintenance, and Construction
Processing Natural Gas Distribution Service Work Requests

b. Specifications for special requirements for natural gas supply should be communicated to Virginia Natural Gas (paragraph 4.c above) as early as known in project development.

c. Submission of required forms, Exhibit A and Exhibit B, is to be done electronically. Each form is to be e-mailed to the Contracting Officers Representative (COR). See paragraph 8 below for information on obtaining copies of Exhibits A and B

d. Contracting Officer's Representative (COR) on this contract is Daniel Wood, 757-878-2489 ext. 228, e-mail daniel.benito.wood@us.army.mil.

6. REQUESTING NATURAL GAS SERVICE WORK:

a. Requesting Natural Gas Service: The procedure for requesting a service connection to a temporary trailer, building under renovation, or newly constructed facility requires the following items be done.

(1) Electronically submit Virginia Natural Gas Commercial Service Information form (Exhibit A) to the COR.

(2) Obtain Site approval from Fort Eustis' Master Planning.

(3) Electronically submit Request for Proposal form letter (Exhibit B) to the COR.

(4) Establish natural gas utility account with Fort Eustis' Utilities Sales Officer at 757-878-6088.

b. Requesting Natural Gas Service Disconnection(s):

(1) Electronically submit Request for Proposal form letter (Exhibit B) to the COR.

(2) Notify Fort Eustis' Utilities Sales Officer at 757-878-6088 of termination in service request.

c. Requesting Natural Gas Service Modification: Electronically submit Request for Proposal form letter (Exhibit B) to the COR.

7. PROJECT FUNDING:

a. The funding for natural gas distribution system work (design, contract administration, and service installation) is funded by each individual project. Fort Eustis and Fort Story Army installations do not maintain an account to fund specific projects, connection fees, or disconnection fees.

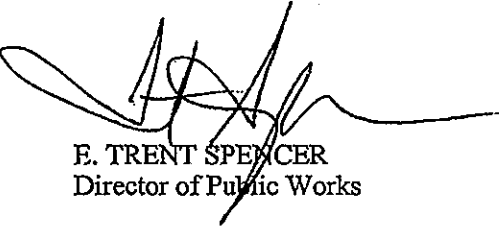
b. The Point of Contact for processing OMA, interagency MIPR, and non-governmental funding for natural gas system work projects is the Utilities Sales Officer at 757-878-6088.

Section:
Operations, Maintenance, and Construction
Processing Natural Gas Distribution Service Work Requests

8. EXHIBITS:

a. Exhibit A, Virginia Natural Gas Commercial Service Information, is a form that, when completed, describes natural gas service requirements for new or renovated facilities. Exhibit A sample is attached. Virginia Natural Gas uses this completed form to determine what service will be necessary to support the new or renovated facility. Exhibit A is available on the Public drive: DPW Public/DPW Forms/VNG DOCs

b. Exhibit B is a form letter that is to be used to request a proposal from Virginia Natural Gas for natural gas utility work. Exhibit B sample is attached. Instructions are in parentheses. Electronic version of the RFP letter is available on the Public drive: DPW Public/DPW Forms/VNG DOCs.



E. TRENT SPENCER
Director of Public Works



Virginia Natural Gas

Commercial Service Information

Customer Information:

Business Name: _____
Service Address: _____ Suite/Unit # _____
City: Fort Eustis State: Virginia Zip: 23604
Date Service Needed: _____ Email: _____
Site Contact: _____ Phone: _____
Legal Name of Property Owner: _____
Owner Mailing Address: _____

New Equipment Gas Load Breakdown:

#	Type of Equipment	Total Btu / Equip	Total Btu
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Existing Equipment Gas Load Breakdown (if applicable):

_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Total Connected Load: _____

Required Delivery Pressure:
(please check one)

- ☐ **7IWC** - Available for all loads on Low Pressure and Medium Pressure mains and services. (larger loads may require a larger fuel line size in order to maintain capacity – using 5PSI may allow for a smaller fuel line size)
- ☐ **2PSI** – Available for loads up to 2,310 CFH/MBH on Medium Pressure mains and services only
- ☐ **5PSI** – Available for all loads on Medium Pressure mains and services only. Pressure delivery above 5PSI may be available for extremely large loads but must be approved by VNG Engineering

Please call our Customer Care Center at 1-866-229-3578 to set up your account. After completing the above information, please mail or fax back to:

Virginia Natural Gas
Market Development Department
3719 E. Virginia Beach Blvd., Norfolk, VA 23502
Fax: (757) 873-6236

REQUEST for PROPOSAL – NATURAL GAS UTILITY WORK

Virginia Natural Gas, Inc., Contract Number GS00P02BSD0181 - Natural Gas Supplies and Services

Date: (Current Date)

SUBJECT: Request for Proposal

Project Manager: (Name, Phone Number)

1. We request that your firm submit a fee proposal for the following project
 - a. Title: (Project Title: Description of Scope of Work)
 - b. Individual Job Order Number: (If applicable)
 - c. Location: (Address or description of location with distance from landmarks or site map)
 - d. Scope of work stated above was discussed at the site with the following people: (List names, Organizations, and phone numbers of people at site visit)
2. Proposal Due Date: (Submit date required – Recommend at least 2-4 weeks from date of submission)
3. Disclaimer:
 - a. You are advised that this letter is not to be construed as authority to proceed with any work or to incur any obligations chargeable to the Government SAF.
 - b. Further, in the event of unsatisfactory fee negotiations, the Government can not assume any obligation for payment of any expense incurred by your firm in the preparation of your fee or premature initiation of services.
4. Attachments:
 - a. Site visit Task Order Scope of Work: Work was discussed and understood on a walk-through by (List names, organizations, and phone numbers.).



REQUEST FOR PROPOSAL



APPENDIX-BB

FORT EUSTIS, OBTAINING DIGGING PERMITS

Instructions for Obtaining Digging Permit at Fort Eustis

At least 72 hours prior to digging:

- Contact “Miss Utility” 1-800-552-7001 to obtain clearance, and
- Send a fax to 757-878-4030, Attn: Robin Hilling, Directorate of Public Works, Fort Eustis. Fax should include the following:
 - Name of your company
 - Billing address
 - Telephone number
 - Fax number of your company
 - Point of contact for this job
 - Phone number of point of contact
 - Purchase order number if you require this on your invoices
 - Brief explanation of the work you are doing
 - Date work will be performed
 - A sketch showing us the area you need marked for underground utility location*

This information will be forwarded to the company that has the contract for underground utility locating at Fort Eustis – Wayjo, Inc. Your company will receive a bill from Wayjo for this service and it’s your responsibility to pay this bill directly to Wayjo. At this time, the cost is \$92 per hour.

*The sketch will need to include enough information for Wayjo to determine the area you want marked. It is not acceptable to send a copy of a Fort Eustis map and circle an area nor to send an aerial photograph of the area. You can mark the area with white paint, stakes, flags, etc. if you wish. If you do this, please indicate this in your fax.

If you have any questions, please contact Robin Hilling, 878-3190 ext 265 or 897-8579.



REQUEST FOR PROPOSAL



APPENDIX-CC

SPECIFICATION

SYNTHETIC SPORTS SURFACE

Appendix J - Attachment A

SYNTHETIC SPORTS SURFACE

01/03

PART 1 GENERAL

The product shall be an impermeable, synthetic sports surface, designed for track and field activities. The system shall consist of a base mat, and of recycled rubber granules bound with a polyurethane binder and a impermeable layer of bi-component urethane coating, and a pigmented spray-applied top finish of polyurethane spray-coating and EPDM rubber granules. The system shall be installed on site.

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Synthetic Sports Surface Material

The Contractor shall submit descriptive technical data on the primers, granules, impermeable layer, structural spray coating, and line marking paint.

The Contractor shall provide written instructions provided by the manufacturer of all the materials used in the construction of the synthetic running track.

SD-07 Certificates

Synthetic Sports Surface Material

The Contractor shall provide documentation showing that the installer and supplier meet the qualifications listed.

1.4 WARRANTY

The product shall be warranted against defects in workmanship, labor, and materials for 60 months at no extra cost to the government.

PART 2 PRODUCTS

2.1 PRIMER

Polyurethane-based primers shall be compatible with the base and track surfacing materials.

2.2 BLACK RECYCLED RUBBER GRANULES

The rubber granules for the base mat shall be recycled rubber, processed and chopped to 0.029 to 0.118 inches, containing less than 4% dust.

2.3 POLYURETHANE BINDER

Binder for the black rubber mat shall be an MDI-based mono-component, polyurethane binding agent. The binding agent shall not have a free TDI monomer level above 0.2%, must be clear in color, not milky, and must be solvent free. The binding agent must be specially formulated for compatibility with SBR stranded or rubber crumb.

2.4 EPDM GRANULES

The rubber granules for the structural spray wearing coats shall be EPDM peroxide cured, man-made rubber containing a minimum 20% EPDM, with a specific gravity of 1.5 +/-0.1, cryogenically processed and chopped to two different gradations, 0.019 to 0.059 and 0.029 to 0.118 inches. The EPDM rubber will be the same color as chosen by the government for the track surface.

2.5 IMPERMEABLE LAYER

The resin for this application shall be a pigmented, thixotropic, two-component, polyol and isocyanate, moisture cured, urethane compound and shall be squeegee applied.

2.6 STRUCTURAL SPRAY COATING

The spray coating shall be a single component moisture cured, pigmented polyurethane, specifically formulated for compatibility with EPDM granules. The coating shall be the color red.

2.7 LINE MARKING PAINT (NOT USED)

PART 3 EXECUTION

3.1 ASPHALTIC SURFACE INSPECTION

Prior to the application of the synthetic track surface, the asphaltic concrete base shall be inspected for conformity to planarity requirements. The surface shall not deviate from the specified grade more than 1.26 inches in 10 feet measured in any direction. All areas not in conformance with the above requirements will be repaired by others, with materials as approved by the manufacturer and allowed to cure prior to application of synthetic course. The surface shall be constructed with a slope of 2.36 inches per 10 feet towards the inner edge.

3.2 CURING

The asphalt surface shall be cured for a minimum of 14 days before construction of the synthetic surface begins.

3.3 CLEANING

The area to be surfaced shall be clean and free of any loose particle or foreign substances (dirt, oil, etc.) prior to commencement of the work.

3.4 PRIMING

The primer shall be spray-applied in accordance with the manufacturer's specifications. Primer shall be applied within 12 hours of synthetic material installation.

3.5 BASE MAT

3.5.1 Mixing

SBR granules and binder shall be mixed according to manufacturer's instructions. Mixing time shall be 2 to 4 minutes.

3.5.2 Application

The material shall be spread onto the asphalt mat using a mechanical tandem leveler. The tandem leveler shall have a heated oscillating screed bar for smoothness and compaction. The heated screed shall be heated to between 158 and 176 degrees F.

The laying procedure shall be bay-to-bay and limiting the length of the passes so as not to have any cold (or cured) lints between the bays. At the beginning of each work day, the traverse joint from the previous day shall be tack coated to ensure adequate bond. Small irregularities remaining in the surface after the tandem leveler has passed shall be removed using a length polyethylene or a Teflon roller.

3.6 IMPERMEABLE LAYER

The components are mixed at the prescribed ration homogeneously with suitable mixing device. This may be a strong drilling machine with a mixing paddle, a static mixing machine, or an automatic mixer. Mixing shall be done for 2 to 4 minutes per batch, depending on the mixer used. The coating shall be squeegee-applied to the base mat, making it impermeable.

3.7 STRUCTURAL SPRAY WEAR COATS

The top layer installation shall commence after the black rubber and sealer coat have cured. The top layer shall consist of a spray coating and EPDM granules. The base mat shall be dry, clean, and free of dust, oils, and greases. The spray coating material shall be mixed with the EPDM granules in a suitable device. Application of the mixture shall include the use of a structure-spray-machine. The mixture shall be placed using two applications in alternate directions with approximately 0.14 pounds per square foot per coat.

3.8 LINE MARKINGS (NOT USED)

3.9 PHYSICAL REQUIREMENTS

The completed surface shall meet the following requirements:

Thickness: 0.512 inches or as specified in the drawings.

Shore A Hardness	ASTM D 2240	55 +/-5
Elongation at Break	ASTM D 412	110%
Tensile Strength	ASTM D 412	645 pounds/sq in (at 68 degrees F)
Compression Set Recovery	ASTM D 395	90-95% over 24 hour period (at 68 degrees F)
Abrasion Resistance	ASTM D 501	0.009 ounces loss after 100 cycles
Chalking	ASTM D 822	No change after 1000 hours

Coefficient of Friction	ASTM D 1984	Dry: 0.70 to 0.75 Wet: 0.60 to 0.65
Resilience	ASTM D 2632	38 to 42%
Tear Resistance	ASTM D 624	60-75 psi

3.10 CONTRACTOR QUALIFICATIONS

The contractor shall submit evidence of at least 20 surface installations in the last 3 years utilizing the type of system specified herein.

The surfacing contractor chosen shall show proof of manufacturing their own polyurethane coatings.

-- End of Section --



REQUEST FOR PROPOSAL



APPENDIX-DD

CD LABELS EXAMPLE

The following are examples of CD Labels:





REQUEST FOR PROPOSAL



APPENDIX-EE

LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS

UNIFIED FACILITIES CRITERIA (UFC)

LONWORKS[®] DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS



APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UNIFIED FACILITIES CRITERIA (UFC)

LONWORKS® DIRECT DIGITAL CONTROLS FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS

Any copyrighted material included in this UFC is identified at its point of use.
Use of the copyrighted material apart from this UFC must have the permission of the copyright holder.

U.S. ARMY CORPS OF ENGINEERS (Preparing Activity)

NAVAL FACILITIES ENGINEERING COMMAND

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

Record of Changes (changes are indicated by \1\ ... /1/)

Change No.	Date	Location

This UFC supersedes: UFC 3-410-02A

UFC 3-410-02**19 Nov 2008**

FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with USD(AT&L) Memorandum dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the more stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Civil Engineer Support Agency (AFCEA) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: Criteria Change Request (CCR). The form is also accessible from the Internet sites listed below.

UFC are effective upon issuance and are distributed only in electronic media from the following source:

Whole Building Design Guide web site <http://dod.wbdg.org/>.

Hard copies of UFC printed from electronic media should be checked against the current electronic version prior to use to ensure that they are current.

AUTHORIZED BY:

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Director, Installations Requirements and
Management
Office of the Deputy Under Secretary of Defense
(Installations and Environment)

CONTENTS

CONTENTS	i
FIGURES	iv
TABLES	v
CHAPTER 1 INTRODUCTION.....	1
1-1 BACKGROUND	1
1-2 PURPOSE	2
1-3 SCOPE	3
1-3.1 HVAC control	3
1-3.2 Building control network.....	3
1-3.3 UMCS interface	3
1-3.4 Other systems.....	4
1-4 APPLICABILITY.....	4
1-5 REFERENCES	4
CHAPTER 2 CONTROL SYSTEM NETWORK.....	6
2-1 INTRODUCTION	6
2-2 ARCHITECTURE	6
2-3 BUILDING CONTROL NETWORK	7
2-3.1 General	7
2-3.2 TP/FT-10 media.....	7
2-3.3 Other media types	8
2-3.4 Media selection	8
2-3.5 Building control network - backbone	9
2-3.6 Building control network - local control bus.....	9
2-4 CONNECTION TO A UMCS	10
2-5 NETWORK DESIGN AND LAYOUT	10
2-6 NETWORK HARDWARE.....	10
2-6.1 Repeater	10
2-6.2 Media converter	10
2-6.3 Router	10
2-6.4 Network bandwidth	11
2-6.5 Other architecture issues	12
2-7 ADDRESSING, DATA TRANSMISSION, AND DATA INTEGRITY	13
2-7.1 Addressing.....	13
2-7.2 Data transmission	14
2-7.3 Data integrity.....	16
CHAPTER 3 DIRECT DIGITAL CONTROL HARDWARE AND CONTROL DEVICES.....	17
3-1 INTRODUCTION	17
3-1.1 SNVTs	17
3-1.2 Functional profile	17
3-2 DDC HARDWARE	17
3-2.1 Application specific controller.....	19
3-2.2 Application generic controller.....	19
3-2.3 General purpose programmable controller	20
3-2.4 Local display panel	20

3-2.5	CEA-709.1 sensors and actuators	20
3-2.6	Building management interface	21
3-3	FIELD DEVICES	21
3-3.1	Sensors (input devices)	21
3-3.2	Actuators (output devices)	21
3-3.3	Multi-function devices	21
CHAPTER 4	TYPICAL CONTROL LOOPS	23
4-1	INTRODUCTION	23
4-2	BASIC CONTROL LOOP	23
4-2.1	Control action and device failsafe	23
4-3	CONTROL LOGIC DIAGRAMS	25
4-3.1	Control logic diagram basic sequence	25
4-3.2	System enabling logic	27
4-3.3	Alarms and shutdown CLD	28
4-4	CONTROL LOOPS	30
4-4.1	Preheat coil control loop	30
4-4.2	Cooling coil control loop	32
4-4.3	Heating coil control loop with setpoint reset	33
4-4.4	Mixed air temperature control with economizer	35
4-4.5	Outside air flow control	45
4-4.6	Variable air volume control loops	48
4-4.7	Variable speed pump control	58
4-4.8	Humidity control loop	62
4-4.9	Alarms	66
CHAPTER 5	CONTROL SYSTEM DRAWINGS	68
5-1	CONTROL SYSTEM DRAWINGS OVERVIEW	68
5-2	CONTRACT DRAWING SET	68
5-3	SYMBOLS AND UNIQUE IDENTIFIERS	69
5-4	POINTS SCHEDULE	71
5-4.1	Overview	71
5-4.2	Responsibilities	71
5-4.3	UMCS content shown on UFGS 25 10 10 points schedules	71
5-4.4	Points schedule description and instructions	71
5-4.5	Points schedule application notes	75
5-5	CONTROL SYSTEM SCHEMATIC	78
5-5.1	Loops and devices	79
5-5.2	Sequencing diagrams	79
5-5.3	Designer notes	79
5-6	LADDER DIAGRAM	79
5-7	CONTROL LOGIC DIAGRAM	80
5-8	SEQUENCE OF OPERATION	81
5-9	THERMOSTAT AND OCCUPANCY SENSOR SCHEDULE	81
5-9.1	Thermostats	81
5-9.2	Occupancy sensors	82
5-9.3	Schedule entries	82
5-10	OCCUPANCY SCHEDULE	83
5-10.1	System default schedule	83

UFC 3-410-02**19 Nov 2008**

5-10.2	Supervisory monitoring and control schedule	83
5-10.3	Number of occupancy sensors to put AHU in occupied mode	83
CHAPTER 6 PROJECT IMPLEMENTATION.....		84
6-1	INTRODUCTION	84
6-2	PLANNING.....	84
PROCUREMENT CONSIDERATIONS		84
6-2.1	Non-proprietary procurement.....	84
6-2.2	Proprietary procurement	84
6-3	DDC DESIGN	85
6-3.1	General	85
6-4	SCOPE OF THE DESIGN.....	85
6-5	CONTRACTING MECHANISMS	88
6-6	COORDINATION	89
6-6.1	IT (DOIM) Coordination.....	89
6-6.2	Mechanical design coordination.....	89
6-6.3	Electrical design coordination	90
6-6.4	Project site coordination.....	90
6-7	EDITING THE SPECIFICATION.....	91
6-7.1	UFGS 23 09 23 edits	91
6-7.2	Other specification editing/coordination	91
6-8	DRAWING PACKAGE	92
6-9	Other.....	92
APPENDIX A GLOSSARY		93
APPENDIX B CONTROL LOGIC DIAGRAM (CLD) TUTORIAL		98
B-1	Introduction	98
B-2	Functional blocks used in control logic diagrams	98
B-2.1	Signal.....	98
B-2.2	Actuator Output.....	99
B-2.3	Sensor Input	99
B-2.4	Hand-Off-Auto (H-O-A) Switch.....	99
B-2.5	Constant Value	99
B-2.6	Signal I/O	100
B-2.7	Logical AND	100
B-2.8	Logical NOT	100
B-2.9	Logical OR	100
B-2.10	On Delay Timer.....	100
B-2.11	Switch	101
B-2.12	Comparator with Deadband	101
B-2.13	Reset Schedule	102
B-2.14	Math Function	102
B-2.15	PID Loop with Enable	103

FIGURES

Figure 2-1. UMCS and DDC System Architecture.....	7
Figure 4-1. Basic Control Loop.....	23
Figure 4-2. Direct Control Action	24
Figure 4-3. Reverse Control Action	25
Figure 4-4. Basic Sequence for a Cooling Coil Control Loop.	26
Figure 4-5. System Enabling Logic.	28
Figure 4-6. Alarms and Shutdown CLD.....	30
Figure 4-7. Preheat Coil Control Schematic.	31
Figure 4-8. Preheat Coil CLD.	31
Figure 4-9. Cooling Coil Control Schematic.	33
Figure 4-10. Cooling Coil CLD.	33
Figure 4-11. Typical Setpoint Reset Schedule for Heating Coil Air Temperature.....	34
Figure 4-12. Heating Coil with Outside Air Reset Control Schematic.....	35
Figure 4-13. Economizer/Mixed Air Temperature Control Schematic.....	36
Figure 4-14. OA-Only Dry Bulb Economizer CLD.	37
Figure 4-15. OA-Only Economizer Setpoint Selection Example for Greenville, NC. ...	39
Figure 4-16. Greenville SC Weather Data for OA-Only Economizer Setpoint Selection Example.	40
Figure 4-17. Mixed Air Temperature Control with RA/OA Activated Economizer CLD.	42
Figure 4-18. OA/RA Economizer Differential Setpoint Selection.	43
Figure 4-19. Greenville SC Weather Data for OA/RA Economizer Setpoint Selection Example.	44
Figure 4-20. Minimum OA Using Two-Position Damper CLD.....	46
Figure 4-21. Minimum OA Flow CLD.....	47
Figure 4-22. Supply Duct Static Pressure Control Schematic.	49
Figure 4-23. Supply Duct Static Pressure CLD.	49
Figure 4-24. Supply Duct Static Pressure Setpoint Reset.	50
Figure 4-25. Supply Duct Static Pressure Setpoint Reset, Setpoint Calculation.	50
Figure 4-26. Supply Duct Static Pressure Setpoint Reset, Ramp-up / Ramp-down.	51
Figure 4-27. Return Fan Flow Control Schematic.	55
Figure 4-28. Return Fan Flow CLD.	56
Figure 4-29. Air Flows in a Return Fan System.....	57
Figure 4-30. Primary/Secondary Pumping Control Schematic.	59
Figure 4-31. Variable Speed (Secondary) Pump CLD.....	60
Figure 4-32. Variable Speed (Secondary) Pump Control - Ladder Diagram.	61
Figure 4-33. Humidity Control System Schematic.....	63
Figure 4-34. Humidity Control Sequencing Diagrams.	63
Figure 4-35. Cooling and Dehumidification CLD.	64
Figure 4-36. Dehumidification / Humidification Sequencing CLD.	64
Figure 4-37. Reheat Coil CLD.....	65
Figure 4-38. Humidifier CLD.....	65
Figure 5-1. Generic Device Symbols.....	69
Figure 5-2. Sample Ladder Diagram.	80
Figure 5-3. Thermostat and Occupancy Sensor Schedule.....	81
Figure 6-1. UMCS Decision Flow Chart.	86

TABLES

Table 5-1: System Reset Button Options and Points Schedule Entries 76

CHAPTER 1

INTRODUCTION

1-1 BACKGROUND

Designers, installers, and operation and maintenance (O&M) staff have struggled with the complexities and incompatibilities of multi-vendor building automation direct digital control (DDC) systems almost since they were introduced in the 1980's. DDC systems are routinely designed and procured on a building-by-building or sub-system by sub-system basis, most notably for heating, ventilating, and air-conditioning (HVAC) systems. In the absence of specifications and criteria for Open systems, Government procurement rules which require competitive bidding make it extremely difficult if not impossible to procure new DDC systems that are compatible with existing ones and that are also compatible with a basewide or campus-wide supervisory system.

In the absence of sole-source procurement, new but incompatible DDC systems result at best in inefficiencies and at worst in complex and non-functioning systems. This is a problem with system-to-system data sharing and is a problem where multiple individual systems need to communicate with a supervisory monitoring and control (front-end) system such as a Utility Monitoring and Control System (UMCS) specified by UFGS 25 10 10. This inability to interoperate is a result of Closed systems due to vendor-specific proprietary elements.

In contrast, Open DDC systems are now available. An Open DDC system is characterized by the ability for any qualified entity to readily modify, operate, upgrade, and perform retrofits on the DDC system. An Open system:

- Permits multiple devices from multiple vendors to readily exchange information.
- Provides the capability to easily replace any device with another device procured from multiple sources.
- May have proprietary components within devices, but these proprietary components must be a small percentage of the overall device.
- May have fees associated with use of certain components.

In short, an Open system is one (integrated, multi-vendor) system where there is no future dependence on any one Contractor or controls vendor.

Open communications and data sharing between multi-vendor systems and with a third party supervisory system is necessary to achieve effective system operation. Some of the benefits and capabilities of Open multi-vendor DDC systems include:

- Competitive procurement, most notably at the building and sub-system level.

- An operator workstation/user interface that provides for the same look and feel for monitoring and control regardless of which vendor's DDC system or sub-system an operator is viewing. As a result, system operators need only become proficient with one user interface.
- An operator workstation/user interface (software) that provides for management of base-wide system operations such as: remote alarm reporting, remote scheduling (on/off control), remote set point override, data logging and reports, energy management including load shedding, utilities monitoring/measurement for the purpose of monitoring energy performance contracts, and initial diagnosis of service calls. As a result, through a single user interface, system operators and managers are afforded the means to efficiently and effectively manage base-wide operations.
- A whole-building approach to systems integration. This includes the efficient inter-connection of HVAC control sub-systems. For example, terminal unit equipment, such as VAV boxes can be readily interfaced to the servicing air handler to provide a call for cooling. In addition, the whole-building approach provides the capability for integrating non-HVAC sub-systems such as fire and security
- Groundwork for establishment of a non-proprietary and openly accessible 'point-database' in support of communications-network management requirements. The Open database approach further insulates the government from the possibility of single vendor lock-in and resulting proprietary procurement.

1-2 **PURPOSE**

This UFC is intended to be used with UFGS 23 09 23 (LonWorks[®] Direct Digital Control for HVAC and Other Local Building Systems). The design concept described in this UFC provides definitive guidance intended to streamline DDC system design and installation leading to maintainable, interoperable, extensible, and non-proprietary control systems. The purpose of this UFC is two-fold;

- **Commonality.** Describe a definitive methodology for the design of building-level control systems and strategies (primarily for HVAC) where the intent is to achieve at least a degree of commonality in systems designed and procured through different channels.
- **Compatibility.** Describe a definitive methodology to obtain multi-vendor systems that can communicate and interoperate with each other and with a supervisory monitoring and control system such as a basewide UMCS through the use of an Open communications protocol.

The Open systems approach described in this UFC is based on ANSI/CEA standard 709.1-B communications protocol (sometimes referred to as LonTalk®) and on LONWORKS® Network Services (LNS®) network operating system. The standard protocol supports Open communications while LNS supports Open network management.

The design of an Open system is not simple. It requires attention to a great deal of detail. This UFC, the specifications, and accompanying drawings were developed to minimize the time and effort required on the part of the designer.

The level of detail contained in this UFC is necessary because of the variety of approaches that can be used to implement ANSI/CEA-709.1-B where, in the absence of this detail, would very likely result in incompatible systems.

'CEA-709.1' is used in this UFC as the shorthand reference to the ANSI/CEA standard 709.1-B communications protocol. In this UFC the term LONWORKS® is used to loosely describe a collection of technologies (including hardware, and software), vendors and installers relating to or based on the CEA-709.1 communications protocol.

1-3 SCOPE

This UFC describes the design of HVAC control systems and the associated building control network that can interface to a UMCS in an Open and non-proprietary manner. The guidance also provides a foundation for the design of other Open building systems.

1-3.1 HVAC control

This UFC provides Open DDC systems guidance for the design of heating, ventilating and air conditioning (HVAC) control systems and other building-level systems, sub-systems and equipment including: primary (air and water) built-up systems, terminal units, and packaged equipment.

1-3.2 Building control network

This UFC describes designer selections for the Building Control Network (BCN) communications including data exchange, architecture, and cabling.

1-3.3 UMCS interface

The DDC system can function as a stand-alone system with reduced functionality (limited user interface, no trending etc.) but is intended to be integrated with a UMCS in accordance with the UMCS guidance (UFC 3-401-01 and UFGS 25 10 10) to provide for remote supervisory monitoring and control of the DDC system. This UFC (3-410-02) and UFGS 23 09 23 helps to ensure that the building-level control system is capable of being interconnected with a UMCS. Even in the absence of a UMCS, this UFC describes the methodology for designer selection and specification of data exchange

parameters including requirements that will facilitate subsequent non-proprietary UMCS interface.

1-3.4 Other systems

Although not directly addressed or specified in the UFC or UFGS the methodology, approach, and many of the requirements defined in this UFC and UFGS 23 09 23 can be used to design other (non-HVAC) Open DDC systems such as water and sanitary sewer systems, electrical systems, lighting, and other utility systems and equipment.

1-4 APPLICABILITY

This UFC and accompanying UFGS 25 10 10 'LonWorks Utility Monitoring and Control System' are for use on all USACE and AFCESA projects. The NAVFAC standard is to use BACnet for its DDC communication protocol and NAVFAC systems should use UFGS 23 09 23.13 20 'BACnet Direct Digital Control Systems for HVAC'. NAVFAC allows the use of LonWorks for upgrades and additions to legacy systems.

At the discretion of and with approval from the assigning government agency (such as the responsible Corps of Engineers District) the control system designer may deviate from the approach defined in this UFC. When deviating from this guidance, systems based on an Open communications protocol are recommended and systems that lead to subsequent proprietary procurement or single-vendor systems are discouraged.

1-5 REFERENCES

American National Standards Institute/Consumer Electronics Association:

- ANSI/CEA-709.1-B, Control Network Protocol Specification, 2002
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UFC 3-410-02**19 Nov 2008**

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CHAPTER 2

CONTROL SYSTEM NETWORK

2-1 INTRODUCTION

This chapter describes building-level Open-communications control system architecture, device functionality, and control devices for HVAC and other building-level monitoring and control applications. The communications network and devices are based on LonWorks® technology and CEA-709.1 communications protocol.

Design of an Open-communications building-level control system does not require an extensive familiarity with the CEA-709.1 protocol, but it is critical that the designer understand that the protocol can be implemented in a manner that is not Open and thus can lead to incompatible systems. Therefore, this chapter contains information pertinent to the design of an Open system that designers likely are not familiar with due to the complex nature of modern networked control systems. While many design decisions have already been made, this chapter describes concepts and selections that the designer should be familiar with when developing a project-specific design.

2-2 ARCHITECTURE

As illustrated in Figure 2-1 a basewide system consists of a UMCS (specified by UFGS 25 10 10) connected to one or more building-level DDC systems (specified by UFGS 23 09 23). The network architecture consists of a basewide IP network and one or more building-level TP/FT-10 networks. DDC UFGS 23 09 23 refers to the building-level TP/FT-10 network as the Building Control Network (BCN). A building point of connection (BPOC) provides an interface between the IP and BCN networks.

Generally, the UMCS will be a basewide system, but it may initially consist of only one (or a few) building control networks with the capability of being expanded to include additional buildings where multiple building control networks can be connected to a single UMCS via a BPOC router at each building.

UFC 3-410-02

19 Nov 2008

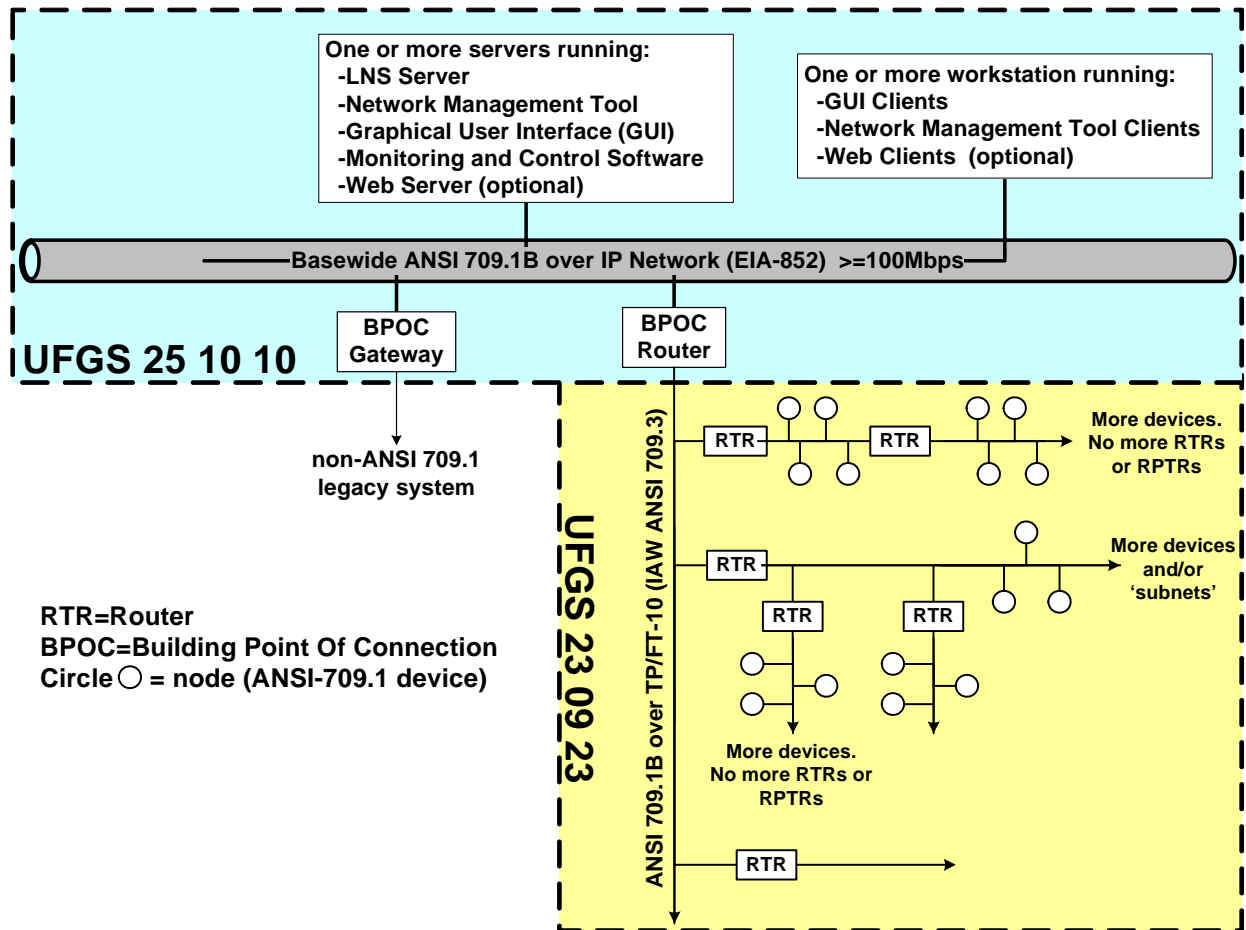


Figure 2-1. UMCS and DDC System Architecture.

2-3 BUILDING CONTROL NETWORK

2-3.1 General

As illustrated in Figure 2-1 UFGS 23 09 23 specifies the building control network (BCN) and requires the use of CEA-709.1 communications protocol over a TP/FT-10 network (in accordance with CEA-709.3) connected in a doubly-terminated topology. The BCN consists of a *backbone* with one or more *local control buses* connected to it via routers. This produces a logically flat network in the building where each node can communicate directly with any other node without the intervention of another controller.

2-3.2 TP/FT-10 media

TP/FT-10 defines a network media and transceiver type:

- The TP in TP/FT-10 stands for Twisted Pair. This is a description of the media that is used to connect the controllers. In this case, a twisted pair of wires is used. CEA-709.3 requires that this twisted pair meet the requirements of CAT-5

UFC 3-410-02**19 Nov 2008**

cable. While the protocol will work over a variety of cable types, CAT-5 (or better) cable is such a widely used standard that requiring the use of it will help avoid incompatibility problems later.

- The FT in TP/FT-10 stands for Free Topology and indicates the transceiver type that controllers on the network will use. The transceiver is responsible for actually transmitting information across the network. Note that while this allows for Free Topology, the specification further restricts the network to a doubly-terminated bus topology.
- Doubly-Terminated Bus Topology requires that the bus be daisy-chained from one device to another with no branches (stubs under 3 meters in length are allowed in accordance with CEA-709.3) with terminators at both ends of the bus. The spec requires doubly-terminated bus topology in order to maintain consistency and since this topology is the easiest to understand and work with.

The protocol communicates at 78 kbps, which translates to roughly 250 packets per second before the network begins to saturate. The specification places specific requirements on how the network is structured and how devices communicate on the network to avoid saturating the network.

For very small systems, a single network segment may be sufficient; you will not need a building network backbone. In this case, the specification may be edited manually to remove the requirements for a building backbone. Note that there are other reasons (explained below) why it might be advantageous to use multiple sub networks in a building.

2-3.3 Other media types

In addition to TP/FT-10, there are two media types that are part of the CEA-709 standard; Power Line (CEA-709.2) and Fiber Optic (CEA-709.4). Furthermore, there are many media/network types available that are not included in the CEA standard. Many of these media types should be avoided, but some such as Radio Frequency (RF) may be useful in some applications.

The IP network is not part of the BCN therefore UFGS 23 09 23 does specify IP media. IP networks are specified in UFGS 25 10 10 'Utility Monitoring and Control System'.

2-3.4 Media selection

UFGS 32 09 23 specifies TP/FT-10 because it is the most common media and thus the most supported and Open option. Use of other media types may limit future competition by giving an advantage to the limited number of vendors whose products support the non-standard media. Therefore alternative media (with the possible exception of Power Line) should only be specified or permitted when it is used in conjunction with TP/FT-10:

- To bridge two TP/FT-10 segments

- As a local control bus connected to a TP/FT-10 backbone

The decision to specify or allow alternative media types is best made by asking “What is gained by using this media instead of TP/FT-10?” and “What is lost by using this media instead of TP/FT-10”? Often the answer to the first question will be that it is a matter of convenience, while the answer to the second will be that the system will become less Open. In these cases, it is likely worthwhile to proceed with TP/FT-10 despite the additional cost/time, as it will prove to be more convenient in the long term.

In general, if the alternative media type requires installation of the media, then there is likely little or no benefit to using the alternative media. If the alternative media permits use of existing media such as power line (PL), radio frequency (RF) or fiber optic (FO), then it may be justified, but the impact on the Openness of the system must be considered.

Specifying or allowing an alternate media type may be warranted where it is needed to meet bandwidth requirements

2-3.5 Building control network - backbone

In accordance with UFGS 23 09 23 routers are the only devices to be connected to the backbone. In addition, only traffic to/from the front end (via the BPOC) is allowed on the backbone. (Note that these requirements may be relaxed for a very small building.) This helps to ensure that ample bandwidth is initially available on the backbone and also helps to accommodate bandwidth needs due to system modifications or future expansions. The backbone is available for connection to the UMCS network via BPOC router as specified by UFGS 25 10 10.

In rare cases, the available bandwidth of the building backbone will be insufficient to accommodate the required traffic between the building and the UMCS. In this case the building Contractor will provide a single TP/FT-10 backbone which the UMCS Contractor (**not** the DDC Contractor) will later break into multiple TP/FT-10 backbones connected by an IP network. A drawback to multiple backbones is that each one requires a BPOC where the BCN is connected to the UMCS network.

Multiple buildings can share a common building-level backbone. For example, two or more adjacent buildings can be physically linked by a common TP/FT-10 backbone as long as network restrictions such as cable length and the total number of nodes as described elsewhere in this UFC and in UFGS 23 09 23 are adhered to. In this case, if the backbone is connected to a UMCS a single BPOC can then be used to connect these buildings to the UMCS. The need for a single BPOC assumes that more than one BPOC is not needed to accommodate network bandwidth usage constraints.

2-3.6 Building control network - local control bus

UFC 3-410-02**19 Nov 2008**

In accordance with UFGS 23 09 23 the local control bus is the only portion of the BCN where DDC Hardware such as controllers may be connected. This helps to ensure that ample bandwidth is available on the backbone.

2-4 CONNECTION TO A UMCS

The BCN will perform all necessary control functionality in a stand-alone mode but does not provide an operator interface for monitoring and control of the network. If the building is to be operated in a stand-alone mode for an extended period and monitoring and control functionality are required, the designer should use the applicable portions of UFGS 25 10 10 to obtain a local monitoring and control system. If the building is to be connected to the UMCS, the UMCS Contractor will be responsible for installation and configuration of the BPOC and integration of the building system into the UMCS.

2-5 NETWORK DESIGN AND LAYOUT

Network layout is left largely to the building-level controls Contractor as specified in UFGS 23 09 23.

2-6 NETWORK HARDWARE

In addition to media, the control network may contain the following types of hardware.

2-6.1 Repeater

A repeater is a device that has two or more input/output ports, connects two (or more) pieces of media, and performs signal regeneration. Signals showing up on an input port get cleaned up, amplified, and sent out of the repeaters output port(s). Repeaters may allow for longer cable runs in some cases, but not others.

2-6.2 Media converter

A media converter is a repeater that changes media types (i.e. TP/FT-10 to PL). Use of non-standard media will likely require the use of media converters where the non-standard media connects to another media type or to a device that supports another media type.

2-6.3 Router

A router is similar to a repeater, but performs the additional function of packet filtering based on destination address. A router can look at the destination address of an incoming packet. If the destination DDC Hardware is accessible via media connected to

a different output port, the packet will be sent out the appropriate output, otherwise the router will do nothing with the packet.

A router maintains a routing table consisting of a list of the domains and subnets that exist on its output ports. A router typically will also contain a “default” entry, which essentially says “If the destination doesn't show up in any routing table entry, forward the packet to another (specified) device (and hope that device can forward it properly).”

A router may be classified as a configured or learning router. A configured router has its routing tables assigned by the installer. A learning router will “learn” its routing tables. Initially, a learning router simply functions as a repeater and forwards all messages. As messages pass through the router, it looks at the source subnet address and learns which of its input ports connects to that subnet; it can then use that information to build a routing table entry for that subnet. While the choice of learning vs. configured router is left to the building Contractor, configured routers are generally preferred.

A router provides two very important functions in a control network:

- It greatly reduces network traffic. By placing devices that need to communicate frequently on a common subnet and isolating that section with a router, the base-wide (or UMCS) network will not be bogged down with local communications between the devices on the subnet.
- It allows devices to send messages to a “distant” controller without knowing the detailed network topology. A device that measures and communicates outside air temperature in one building and that sends this outside air temperature measurement to another device in another building only needs to forward the message to its router. The router is then responsible for knowing how to send the message on towards the destination device.

2-6.4 Network bandwidth

In accordance with UFGS 23 09 23 the Contractor is responsible for selecting the details of the architecture and ensuring that the proposed system (devices, network bindings, and network architecture) does not saturate the network.

While it is the Contractors responsibility to design and propose a network that does not exceed the network's bandwidth capacity, UFGS 23 09 23 provides additional requirements to help ensure those limits are not exceeded:

- Use the UFGS 23 09 23 specified backbone and local control bus architecture
- Group devices that need to communicate often on a common local control bus

- Limit the amount of information sent to the UMCS. A modern UMCS can easily demand data from the local controls faster than the building network can deliver the data. Coordinate with the UMCS installer to limit “always-active” data requests from the UMCS such as trending to those really required by the installation.
- Ensure the Contractor is careful in selecting data transfer rates and integrity methods. Use “Send on Change” with reasonable change values to avoid sending data more often than required. Limit “Unacknowledged Send Multiple” and “Send Acknowledged” transmissions to critical data only.

Segmenting the network into local control buses and a backbone is the easiest way to manage network traffic and not overload the network. The intent is to place devices that need to communicate frequently on a common local control bus. The requirement that only routers be connected to the backbone ensures that traffic from a (potentially) congested local control bus does not clog the backbone – the router will keep local traffic on the local control bus and off the backbone. Traffic between devices and the front-end UMCS will utilize the building backbone. The specification requirement that no node has more than two routers between it and the backbone helps ensure that the installer doesn't bog down a local control bus by forcing traffic from a second local control bus to traverse the first local bus to get to the backbone.

2-6.5 Other architecture issues

2-6.5.1 Multiple controllers per HVAC system versus single controller

The LONWORKS industry supports the notion of “distributed control”. In a conventional DDC system, a single relatively powerful controller with ample inputs and outputs is often used to implement a complete sequence of operation. While there are CEA-709.1 controllers that support this approach, another possibility is the use of multiple simpler interconnected controllers. For example, instead of using a single controller to control an air handler, the mixed air dampers may be controlled by a dedicated controller (or even a so-called “smart actuator”) which obtains relevant temperatures from other sensors on the network (“smart sensors”), obtains occupancy status and other information from other devices on the network and drives the dampers. Similarly, the cooling coil valve could be driven by a simple controller whose only output would be a 4-20 mA control signal to the valve.

While this approach to HVAC control is not necessarily unique to CEA-709.1 based hardware, this approach does seem to be better supported by LONWORKS than other protocol technologies. As with any approach, distributed control has its own set of advantages and disadvantages.

Advantages:

- Simple controllers. Programmable controllers are not needed, which eliminates custom programming and programming software. A small selection of simple controllers can be used for all control schemes. This would allow an installation to standardize on a set of controllers and ease the training requirements for the O&M Staff.
- Supportable by multiple vendors. Since the devices have simple functionality it is easier to find a replacement device from a different vendor with the same functionality.
- Documentation. It is easier to document the actual controller and controller functions/settings.
- No long home-runs of wire. Controllers may be located at the sensors/actuators they interface, or the sensors/actuators may be the controllers ('smart' sensors/actuators) which reduced the wiring requirements.

Disadvantages:

- Execution of the system sequence may require communication between multiple controllers which in turn may require a functional network. One work-around to this issue is to create a local control network dedicated to the system and isolate this from the rest of the building with a router (this will protect the local network from most network failures elsewhere in the building).
- Harder to document. While the individual controllers were easier to document, the system sequence may be harder to document since it is distributed among multiple controllers.
- Controllers not in one location. The controllers for a single system may be scattered about the mechanical room, or even outside the mechanical room.

UFGS 23 09 23 places the burden on the Contractor to decide when distributed control should be used.

2-7 ADDRESSING, DATA TRANSMISSION, AND DATA INTEGRITY

2-7.1 Addressing

All network protocols, including CEA-709.1, define an addressing scheme: a method of delivering messages to a specific device on the network. CEA-709.1 defines several such methods. The Domain/Subnet/Node method is shown and used in the current UFGS/UFC criteria. While it requires more care to set up than the use of NodeIDs (another common method) the advantage of the Domain/Subnet/Node method is that the addressing scheme can and should reflect the logical organization of the control

network and is therefore more readily managed. For example, a large building may consist of subnets 105 – 110, with a large AHU controller at subnet 108, device 1 and its associated VAV boxes at subnet 108 including devices 2-35. In comparison, if NodeIDs were used, the addresses would all essentially be random numbers between 1 and 281 trillion. The specification requires the use of the Domain/Subnet/Node addressing scheme with documentation of the NodeIDs for DDC Hardware.

The installer should assign the Domain/Subnet/Node address to DDC Hardware according to installation-specific guidelines established for the UMCS. The choice of whether or not to put all devices on a single domain is complex. In concept the use of a single domain base-wide is straightforward, but in practice there are a number of issues to be considered:

- Devices that need to communicate with each other should be on the same domain, as you cannot bind network variables across domains. You can have the front end read a value from a controller on one domain and write it to a different controller on another domain, but this is discouraged. This “limitation” is seldom an issue; controllers that need to talk to each other are generally on the same subnet and almost never required to be on different domains.
- There are performance issues associated with large domains. The network configuration tool will open a 500 device domain faster than it will a 2000 device domain, so in this regard, it is better to have four 500 device domains than one 2000 device domain.
- A typical installation may have a few vendors (say four or five) who install the vast majority of building networks on the installation. While the specification is designed to allow multiple vendors to work with a single base-wide LNS database, there may be advantages to allowing each major vendor to have a separate LNS database (reduced potential for finger pointing, less potential for device renumbering, easier LNS database merging, perhaps easier for building vendors to use their own network configuration tool, etc.). This is not a problem, as the UFGS requires that the Monitoring and Control software support multiple LNS databases. This will require multiple domains, as a single domain cannot span multiple LNS databases.

As a practical matter, any single DDC project will almost certainly use a single domain; it is highly unlikely that multiple domains will be used within a single contract. The subnet address will often reflect some logical grouping within the system. A single subnet will often suffice for a smaller building; larger buildings may require several subnet addresses. At the lowest level are individual node addresses; each DDC Hardware device on a subnet must have a unique node address.

2-7.2 Data transmission

The CEA-709 data transmission speed is 78.1 kbps and there are 2 primary mechanisms through which data transfer data occurs; polling and binding. These data transfer aspects of the protocol along with the quantity of data transferred govern how much bandwidth is used.

Polling occurs when a receiver of data requests data from a transmitter. This is generally a periodic event with a defined period. Collection of trend data is an example of polling where every 15 minutes a UMCS front-end workstation requests data from several DDC hardware devices. Polling can occur at any time and a device can always poll another device for data.

Binding is used to create another form of data transfer where bindings between one or more devices are set up during network configuration. As a result of binding, a data source sends (on its own initiative) data to a recipient. There are several parameters that control the frequency of this transfer:

- Change of Value (COV). The transmitting device can be configured to only send the data if it changes by a minimum specified amount. For example, a controller that is measuring outside air temperature might be configured to transmit a new temperature value only if the current value changes, from the last value transmitted, by greater than 0.5 degrees. UFGS 23 09 23 requires use of COV whenever possible (some DDC Hardware, particularly ASCs, may not support use of COV in all situations).
- Minimum send time. The transmitting device can be configured not to send the data more often than once every **X** seconds. This is an important parameter for limiting network traffic; most HVAC control applications (except for example pressure or flow control applications) do not require “real-time” data and therefore data need not be transmitted more often than once every couple of seconds even if it is rapidly changing. UFGS 23 09 23 requires a minimum send time of 5 seconds for traffic between DDC Hardware
- Maximum send time. The transmitting device can be configured to send the data at least once every **X** seconds, even if the value is not changing. This is generally a good practice just in case something goes wrong. For example, if the receiving device is reset, it may not “remember” older data and therefore may not have the value until it is retransmitted. A typical maximum send time might be 20 minutes. UFGS 23 09 23 requires a maximum send time of 20 minutes for traffic between DDC Hardware

While binding is almost always preferred to polling due to better network efficiency, there are several cases where polling is recommended:

- When the data transmission is of a temporary nature, such as points on a graphic. If the points were bound to the graphic, all points on all graphics would be bound and all the devices would send all the data to the Monitoring and Control server constantly, even if the graphic was not being viewed. By

polling, the Monitoring and Control server can request only the data it needs – i.e. data for the graphics pages currently being viewed.

- When the device does not support binding. Frequently, the Monitoring and Control server and Local Display Panels will not support binding data to them. In this case, polling is the only option for data transmission.

2-7.3 Data integrity

There are several parameters that govern data integrity: how the protocol ensures reliable data communication with less-than-perfect hardware, noisy lines, “glitches” and other real-world events. With binding, there are several common means to send data and each has advantages and disadvantages:

- Unacknowledged send once. The data is sent one time and one time only. This requires the least network bandwidth, but does not provide any assurance that the data reaches the recipient.
- Unacknowledged send multiple. The data is sent multiple times (typically three). It is up to the recipient to deal with receiving the same data multiple times. This requires more bandwidth than the send once option but is still fairly fast because the transmitter does not wait for any acknowledgement. It simply sends the data **X** times and moves on.
- Acknowledged send. The data is sent once. Upon receipt of the data, the receiver must send an acknowledgement message back to the transmitter. If the transmitter does not receive the acknowledgment within a pre-determined period of time (the “timeout”), the transmitter will resend the data. This is the slowest method, but is a good trade-off between reliability and network bandwidth usage. This is typically used for alarms, where it is essential that the data gets transferred. This is the required method for traffic between DDC Hardware. (Communication between DDC Hardware is almost always part of a control sequence.)

CHAPTER 3

DIRECT DIGITAL CONTROL HARDWARE AND CONTROL DEVICES

3-1 INTRODUCTION

This chapter describes control devices and the DDC Hardware specified in UFGS 23 09 23 including the extended requirements needed to implement an Open system. It also describes the related terms and concepts pertaining to LONWORKS technology and the underlying CEA-709.1 communications protocol (more commonly known as LonTalk®). For additional technical information on LONWORKS, see:

<https://eko.usace.army.mil/fa/bas/>

3-1.1 SNVTs

During inter-communication, nodes share data and information by transmitting and receiving network variables (the messages exchanged between devices). Specifically, UFGS 23 09 23 requires the use of the Standard Network Variable Types (SNVTs) as defined by LonMark International. In general a SNVT is a command, a status, or a variable (such as temperature, pressure, humidity, etc.), but a SNVT can contain other types of information.

3-1.2 Functional profile

LonMark International defines Functional Profiles for LonWorks devices or nodes. A Functional Profile describes standard node communications and consists of mandatory and optional input and output SNVTs, mandatory and optional configuration properties, and finally a manufacturer specific section.

Functional profiles are useful in that they help define communication/data exchange requirements and network interfaces, but they do not go far enough to ensure that devices will interoperate with other devices in accordance with UFGS 23 09 23. At issue is that control sequences in UFGS 23 09 23 require SNVTs that are only optional in the corresponding Functional Profile. Therefore, the Functional Profile, in itself, is not sufficient to ensure that a device has the required inputs/outputs for a specific sequence of operation. Points Schedule drawings, as specified in UFGS 23 09 23, are used to define these extended requirements.

While there is a LonMark Functional Profile available for scheduling of devices, it is unsuitable for the control sequences defined in DDC UFGS 23 09 23 and should not be used.

3-2 DDC HARDWARE

Any device, other than network hardware, that communicates over the CEA-709.1 network is considered DDC Hardware. In general, the term DDC Hardware is used interchangeably with the term controller, but there are devices such as smart sensors and actuators that are considered DDC Hardware but are not traditionally called controllers even though they may in fact have control functionality (like a feedback control loop). Another term commonly used is “node”, where a LonWorks node is any device that resides on the LonWorks network and communicates via the CEA-709.1 protocol. This includes smart sensors, smart actuators, and controllers, along with a variety of other microprocessor-based devices.

There are several requirements that all DDC hardware must meet. They must:

- Be locally powered: Basically, there are two ways to provide power to a piece of DDC hardware. A link powered device receives its power from the same wire that is used for communication. A local powered device receives its power on a separate set of contacts. Note that a local powered device does not typically include it's own transformer, the requirement is simply that the device be connected to a local power source, not one over the network. This specification requires that one method be used for consistency and ease of O&M. As the more common and more intuitive option, local power was selected.
- Communicate only using CEA-709.1B
- Meet the LonMark Interoperability guidelines. These guidelines provide a foundation for interoperability and devices meeting these guidelines are readily available.
- Use a TP/FT-10 transceiver for use on a TP/FT-10 network
- Support 78.1 kbps data transmission
- Be provided with an external interface file (XIF file). This is a text file that tells a Network Management Tool what the interface (inputs, outputs, configuration settings) of the controller is.
- Meet accuracy requirements. Requirements for I/O accuracy are not given directly; instead the requirement is that end-to-end error (i.e. accuracy at the SNVT value) be no worse than 150% of the allowed sensor error. This allows the Contractor flexibility in matching sensor ranges and controller A-to-D converters to the application.

Some of these requirements may be difficult to confirm for some devices, specifically programmable controllers. Product data sheets can provide a good indication of whether a device, particularly an application specific controller, meets LonMark Guidelines. In addition, LonMark International has a self-certification checklist that vendors can use to certify that a device meets the LonMark Guidelines.

DDC Hardware is further broken down into three categories, Application Specific Controllers, Application Generic Controllers, and General Purpose Programmable Controllers, each of which has additional requirements it must meet.

3-2.1 Application specific controller

An application specific controller (ASC) is supplied with a factory-installed (and fixed) application program. Example ASCs include VAV box controllers, fan coil unit controllers, 'smart' actuators and 'smart' sensors. An ASC is *configured* for the specific application in which it is used. This configuration does not change the function of the device, but changes settings within the device such as setpoints and other operational settings. The specification requires that ASCs meet several requirements in addition to the general DDC Hardware requirements. For example:

- An LNS® Plug-in must be provided to perform device configuration and all configuration needed for the device must be able to be performed either via this Plug-in or physical settings on the device itself (such as jumpers or dip-switches). The purpose of this requirement is to prevent the need for proprietary configuration tools. Note that UFGS 23 09 23 allows this requirement to be waived in cases where a device with a plug-in is not available (where there is no commercially available device that contains a plug-in) and the Government has approved the exception.
- The ASC must be LonMark Certified. Again, an exception can be made for cases where there is no certified device available for a specific application.

Depending on the needs and requirements of the project or specific applications, such as minimal cost and simplicity, the designer may choose to prohibit the use of General Purpose Programmable Controllers (GPPCs) described below and instead require the use of ASCs. In doing so, the designer should first ensure that appropriate products are commercially available for the application.

3-2.2 Application generic controller

An application generic controller (AGC) is similar to an ASC, but has a limited programming capability. Programming these controllers does not change the controller ProgramID, so these controllers can be (and often are) programmed through an LNS plug-in. UFGS 23 09 23 has separate requirements for AGCs which includes a mix of ASC and GPPC requirements.

While in general, these controllers are limited in power and flexibility compared to GPPCs, most of these controllers are capable of executing the sequences specified in UFGS 23 09 23. Further, since they can be re-programmed remotely and without changing the program ID, they are often preferred to GPPCs.

3-2.3 General purpose programmable controller

A general purpose programmable controller (GPPC) comes from the factory without a fixed application program (i.e. has no application program installed, or the program may be over-written). This type of controller must be *programmed* for the application in which it is used. This makes the GPPC more flexible and powerful than an ASC, but more complicated and costly as well. The specification requires the GPPC to meet several requirements in addition to the general DDC Hardware requirements:

- The programmed GPPC shall conform to the LonMark Interoperability Guide. This requirement is in lieu of the requirement (for ASCs) to be LonMark certified.
- The software that is required to program the controller must be provided. This software will be needed if it is ever necessary to reprogram the controller.
- A copy of the program that is installed in the controller must be submitted. This copy needs to be in the form of source code readable by the provided programming software. Not only can this program can be loaded into a replacement controller, it can be modified to change the functionality of an existing controller. The intent of this requirement is so that the installation can later modify the program or replace the controller without requiring assistance from the original vendor.

3-2.4 Local display panel

The local display panel (LDP) is an ASC with a small display screen and some navigational buttons used to view and/or change the value of network variables. Although the functionality of an LDP is limited as compared to an operator workstation computer, it can be a useful diagnostic tool for maintenance staff.

There is potential for conflict between the LDP and the Monitoring and Control Software when using an LDP to change (override) a network variable. The device receiving the override will be overridden to whichever source most recently "spoke" to it which may result in some confusion. The value of specifying LDP override capability may be sufficiently beneficial to compensate for the potential confusion, but this should be coordinated with the project site.

3-2.5 CEA-709.1 sensors and actuators

Sensors and actuators may communicate using the CEA-709.1 protocol over the TP/FT-10 Building Control Network. These sensors and actuators are considered to be ASCs (or possibly GPPCs as appropriate) in addition to being actuators or sensors and therefore must meet the requirements of both the sensor/actuator and of an ASC (or GPPC). A common example of this device is a variable frequency drive unit containing a TP/FT-10 network interface. The use of sensors and actuators that contain a TP/FT-10 interface, in accordance with UFGS 23 09 23, is left to the discretion of the

Contractor. Project specific requirements may dictate that the Designer require a TP/FT-10 interface.

3-2.6 Building management interface

A small scale building-level network might call for a building management interface (BMI) node. The BMI should only be used in the absence of a UMCS, and is not specified in either UFGS 23 09 23 or UFGS 25 10 10. The BMI provides web services and can also perform scheduling, logging (trending), alarming, and other supervisory interface functions. A disadvantage of the BMI is that, while it is an Open protocol device at the building level, it likely will not support Open standard communications over the IP network in accordance with UFGS 23 09 23 or UFGS 25 10 10. Specifically, the BMI does not perform routing functions. If it is later decided to connect the building to a UMCS, the BMI will need to be replaced and any functionality in the BMI will need to be accomplished in an Open manner in accordance with UFGS 23 09 23 or UFGS 25 10 10. At the very least, an EIA-852 router will need to be installed as the BPOC.

3-3 FIELD DEVICES

3-3.1 Sensors (input devices)

Many of the control sequences have, as a designer option, a safety reset button (RST-BUT). In the event that a safety input to the DDC Hardware is activated, resulting in control system shutdown, the RST-BUT is used to reset the control system. Exact requirements and function are dictated by the specific sequence of operation. When determining whether to require a button or allow reset from an operator workstation, consideration should be given to the convenience of reset from an operator workstation versus the safety of initiating a reset by a technician with “eyes-on” the system.

Night stat is the common name for the building temperature (BLDG-T) low-limit sensor. This is typically just a temperature sensor placed in a representative location that acts as a safety to turn on the heat if the building gets too cold. In a single-zone system, the night stat may simply be the zone temperature sensor (ZN-T).

3-3.2 Actuators (output devices)

Electric actuation is recommended for all new construction and for any location where a source of control-grade compressed air does not already exist. Where the installation requires pneumatic actuation, ensure that a compressor is specified.

3-3.3 Multi-function devices

Thermostat (STAT). While the technical definition of a thermostat is a self-contained controller that generates a control output, this UFC uses a more loose definition. In this UFC and in the accompanying specifications a thermostat is defined as a space

mounted device with inputs and outputs to and from a piece of DDC hardware. Ordinarily a STAT will contain a room/space temperature sensor and provide display of space temperature. Depending on the application, it might also provide for occupant (user) adjustment of the space or room setpoint. The STAT might also contain a momentary contact button (input to DDC Hardware) that permits the occupant to override the unoccupied mode so as to temporarily place the control system into the occupied mode. This is sometimes referred to as OCC Override. Alternatively, the STAT might contain an occupancy sensor to provide the OCC Override function. Some sequences have additional operator inputs (typical mode or fan controls) that require additional input(s) at the STAT. In many cases, a STAT will fall under the definition of an ASC, in which case it must meet the DDC Hardware requirements.

CHAPTER 4

TYPICAL CONTROL LOOPS

4-1 INTRODUCTION

This chapter describes typical control loops including designer selections such as control setpoints. Part of the intent is to describe preferred or definitive control loops where commonality from designer-to-designer and project-to-project will aid in the operation, maintenance, and support of the installed control systems. The development of control logic diagrams, used to define detailed control sequences, is also described.

4-2 BASIC CONTROL LOOP

A basic control loop schematic, as shown in Figure 4-1, is comprised of a sensor, a DDC, and the controlled device. A sensor is the input component of the control loop that measures the controlled variable (such as temperature, relative humidity, pressure, air flow rate, or carbon dioxide). A controller is the decision-making component of the control loop that compares the controlled variable to the setpoint and provides a corrective output signal. Controlled devices are output components of the control loop and typically include valves or dampers.

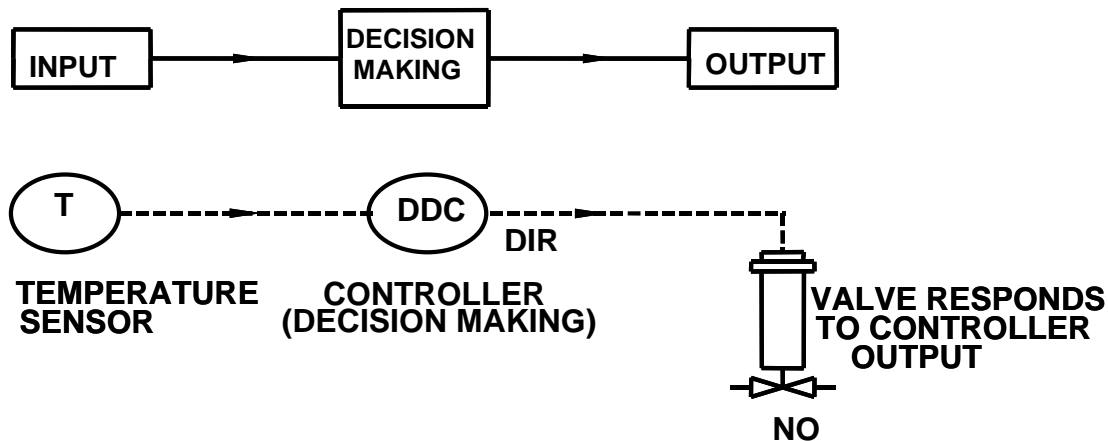


Figure 4-1. Basic Control Loop.

4-2.1 Control action and device failsafe

If the power source or control signal to an actuator (or other device) is lost or disconnected it may be desirable for the device to move to a failsafe position. The intent

is to provide for equipment protection, such as protection against freezing, and must be selected/specified by the designer. Failsafe positions can be: normally open (NO), normally closed (NC), or Fail-In-Last-Position (FILP). A NO device will move to the open position and a NC device will move to the closed position. In the case of an actuator, movement to the NO or NC position is accomplished under the power of a spring internal to the actuator. A FILP device ordinarily has no spring and as a result, upon loss of actuator power or control signal, the device remains fixed at its last position. FILP is generally not useful nor advised as a failsafe but is usually the most inexpensive option for an electric actuator and is intended for applications where a true failsafe is not needed such as terminal unit actuators. Generally, terminal units do not require NO or NC actuators; FILP is sufficient. Valve and damper failsafe positions are to be specified. When a device is specified as either NO or NC, the corresponding direct (DIR) or reverse (REV) action of the controller should also be specified such that the action pairs up with the specified failsafe position.

4-2.1.1 Direct control action

A controller that has been configured to provide DIR control action will generate an output that moves in the same direction as the controller input. An example control loop that uses DIR control action with a normally open valve is shown in Figure 4-1. Figure 4-2 shows how the controller output changes as the temperature input changes. As the temperature input increases, the DIR acting controller output increases, and the normally open valve will move towards the closed position.

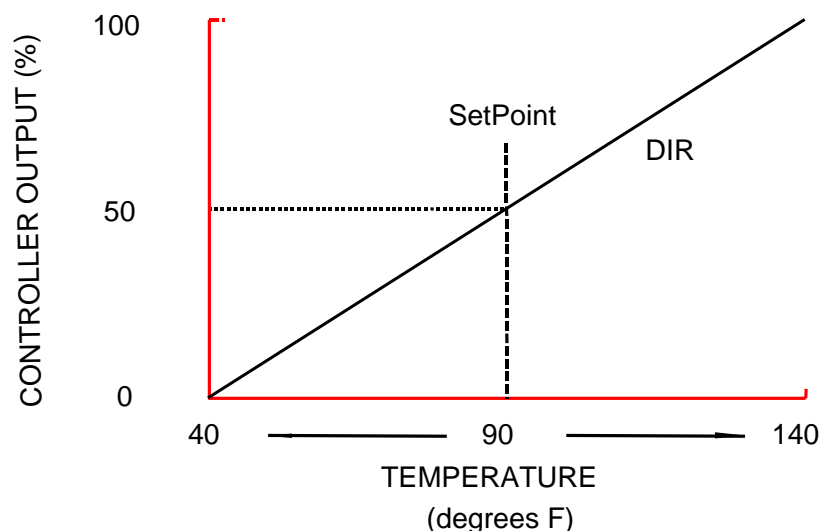


Figure 4-2. Direct Control Action

4-2.1.2 Reverse control action

A controller that has been configured to provide REV control action will generate an output that moves in the opposite direction as the controller input. Figure 4-3 shows how the controller output changes as the relative humidity input changes as a result of REV control action. An example of REV control action would be a humidifier application with a normally closed valve. As the humidity input increases, the REV acting controller output decreases, and the normally closed valve will move towards the closed position.

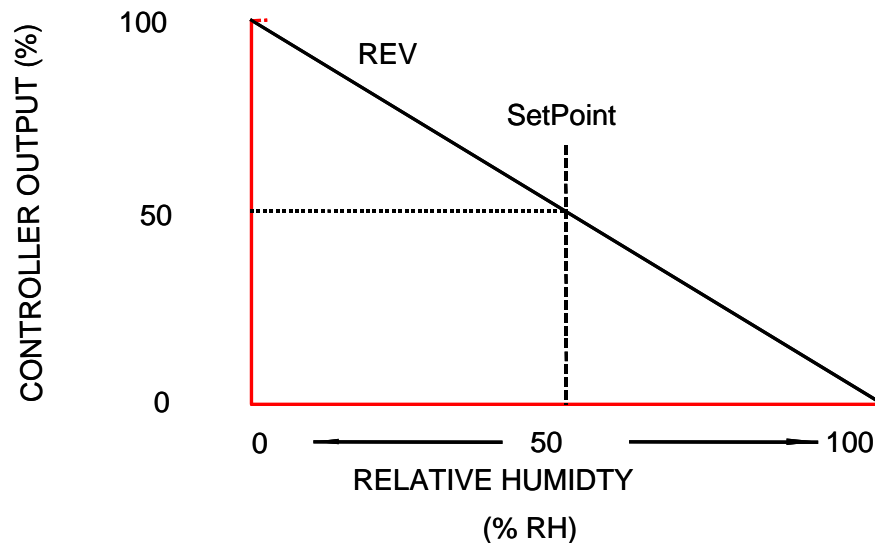


Figure 4-3. Reverse Control Action

4-3 CONTROL LOGIC DIAGRAMS

A control logic diagram (CLD) is a detailed graphical and functional representation of the control system sequence of operation. The CLD supplements the written sequence of operation. Designer use of a CLD is optional, but recommended.

Ordinarily, the CLD will consist of a basic sequence that describes a control loop. In addition it will include enabling logic used to activate the loop. The enabling logic used depends on the loop and on the requirements of the application. An example of basic enabling logic for a mixed air control loop is: 1) the economizer must be 'on', and 2) the air handling unit fan(s) must be running.

4-3.1 Control logic diagram basic sequence

The procedure for developing a CLD begins with a basic sequence which typically includes a proportional-integral-derivative (PID) control loop with a process variable and

a setpoint (SP) input along with a control signal output. Figure 4-4 shows an example of a basic PID block. It has two analog inputs, one analog output, one (shown) configuration property, and one binary input:

- SA-T: Supply Air Temperature, an analog (A) hardware input.
- SA-T-SP: Supply Air Temperature, an analog input from “elsewhere”. This signal may be defined elsewhere on the CLD for that system, it may be an output from another system, or it may be shown as an input to the system on the Points Schedule drawing. In this case, SA-T-SP is a configured setpoint and would be shown as such on the Points Schedule drawing.
- CLG-V-C: Cooling Valve Command, a hardware analog (A) output. Note that the CLD does not distinguish between NO and NC valves nor DIR or REV control action. These details are specified/shown in the control schematic drawing. From the perspective of the CLD, a 10% signal output corresponds to the valve being 10% open, it is irrelevant whether this corresponds to 9 Volts, 8 PSI, or any other “physical” value. Similarly, the CLD does not distinguish DIR acting versus REV acting control – the CLD treats all controllers as direct acting where the output moves in the same direction as the controller input.
- CLOSED: A default value; the value assumed by the PID output when the loop is disabled. This will be a configuration property whose value will also be shown on the Points Schedule. Note that there are many other configuration properties associated with a PID loop; the others are not necessary for a basic understanding of the operation of the system and are not shown on the CLD.
- CLG-ENA: Cooling Enable, a binary input from “elsewhere”. In this case, CLG-ENA will be defined/generated in the system enabling logic portion of the system CLD. When this signal is TRUE, the loop is enabled, active, and controlling CLG-V-C to maintain SA-T at SA-T-SP. When this signal is FALSE, the PID loop output will assume the (shown) default output.

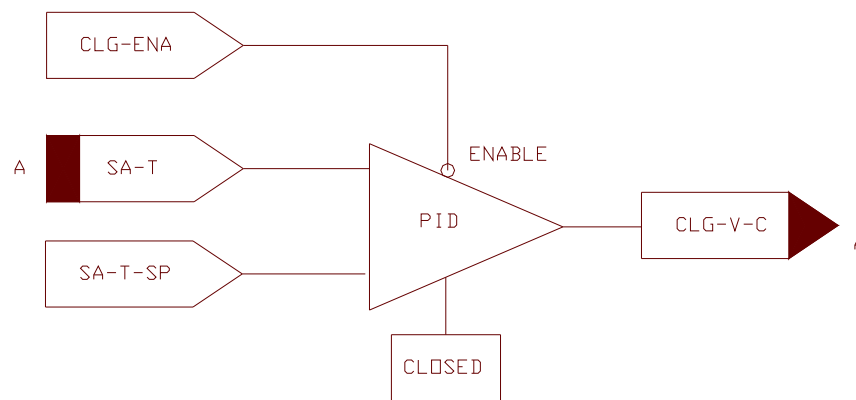


Figure 4-4. Basic Sequence for a Cooling Coil Control Loop.

4-3.2 System enabling logic

Figure 4-5 shows enabling logic at the system level, including the logic that enables the cooling loop (CLG-ENA) as shown in the lower right hand corner of Figure 4-5. This block has multiple inputs and outputs:

- SF-S: Supply Fan Status; a hardware binary (B) input proof that the supply fan is running. This can be from a current sensing relay, flow switch, or feedback from a variable frequency drive unit; the exact mechanism is unimportant.
- RF-S: Return Fan Status; a hardware binary (B) input.
- FAN-DIS: Fan Disable; a binary signal from the “Alarms and Shutdown” block; this is TRUE when an alarm occurs and the air handling unit should be shutdown.
- SYS-OCC: System Occupancy; a network binary signal from the system scheduler providing system occupancy status.
- BLDG-T-LL-SP: Building Temperature Low Limit SetPoint; a configured analog input. This is the night-setback temperature.
- BLDG-T: Building Temperature; a hardware analog (A) input from the night stat
- FAN-FAIL: A binary signal (to the “Alarms and Shutdown” block diagram) indicating a fan has failed (not running when it should be).
- SYS-ENA (and SF-SS): A binary signal indicating that the system is enabled and running. Note this same signal is also used as a hardware binary (B) output to the fan. This signal is true whenever the system is commanded to be on (either due to occupancy or night stat) and the system is not being shutdown due to an alarm condition.
- CLG-ENA (and ECO-ENA): A binary enable signal to the cooling block and economizer blocks, respectively, enabling those loops. This signal is enabled whenever the SYS-ENA is TRUE and the occupancy is OCCUPIED or WARM UP / COOL DOWN.
- MINOA-ENA: A binary enable signal to the MIN-OA control block. This signal is enabled whenever the SYS-ENA is TRUE and the occupancy is OCCUPIED.

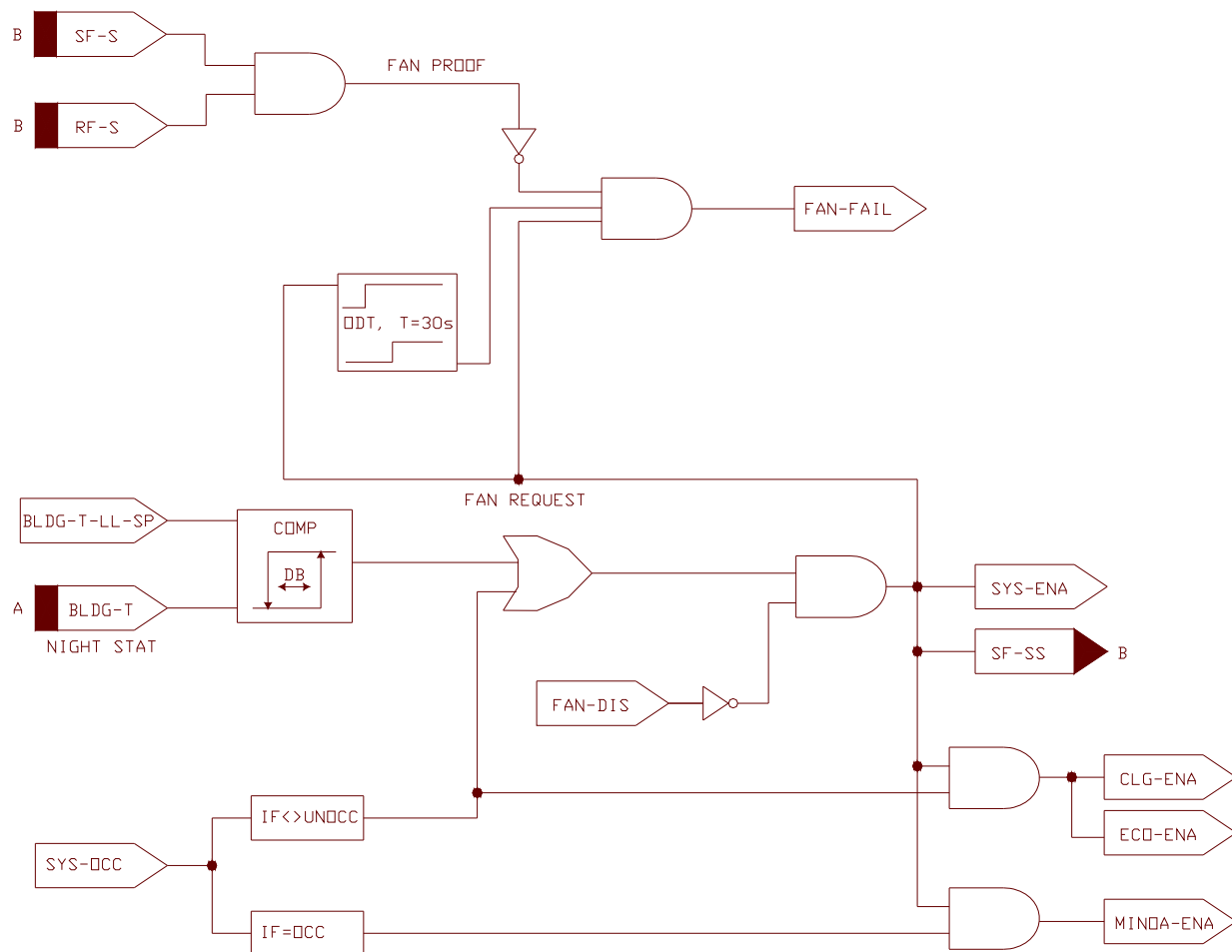


Figure 4-5. System Enabling Logic.

4-3.3 Alarms and shutdown CLD

Figure 4-6 shows logic used to shut the system down in case of an alarm condition. It has multiple inputs and outputs:

- PH-T-LL: Preheat Temperature Low Limit; a hardware binary (B) input from the freeze stat. This will be from a contact that closes upon a drop in temperature below the freeze stat setpoint. Therefore this signal is true when the freeze stat “trips”. Note there is an implied setpoint here: the freeze stat trip setting. This is not shown in the CLD because this as a hardware configuration setting (something that gets adjusted via setscrew at the freezestat) and is shown in the Points Schedule. Note that the example CLD shows a freeze stat for the preheat

coil. In the absence of a preheat coil the freeze stat would be in a different location (such as at the cooling coil).

- **SA-P-HL:** Supply Air Pressure High Limit; a hardware binary (B) input from the duct high pressure limit safety switch located at the outlet of the fan. This input is from a contact that closes upon a rise in pressure above the pressure switch setpoint. As with the PH-T-LL the SA-P-HL setpoint is implied in the CLD and its setting is shown in the Points Schedule. Note that while the example CLD shows a SA-P-HL this only applies to a VAV air handler and (ordinarily) should not be shown in a non-VAV system.
- **SA-SMK and RA-SMK:** Supply (Return) Air Smoke; hardware binary (B) inputs from the smoke detectors.
- **FAN-FAIL:** A binary signal from the System Enabling Logic indicating fan failure.
- **RST-BUT:** Reset Button; a hardware binary (B) input (to the DDC control logic) from a pushbutton located at the AHU (or AHU control panel). This signal clears the system failure and resulting shutdown due to any of the above alarms.
- **FAN-DIS:** Fan Disable: A binary (B) signal which goes to the System Enabling Logic to disable the system.

The CLD shows one other component, a set/reset (S/R) Latch used to “remember” the system failure until the failure is cleared via the RST-BUT input. The designer needs to specify the setpoints for the PH-T-LL and SA-P-HL alarms.

Note that the alarm conditions are dealt with directly by the sequence running in the DDC Hardware. As a general rule, alarm conditions must be dealt with in the control system sequence of operation. While an alarm should be sent to the M&C server, the sequence must place the system in a “safe” mode and not rely on operator intervention.

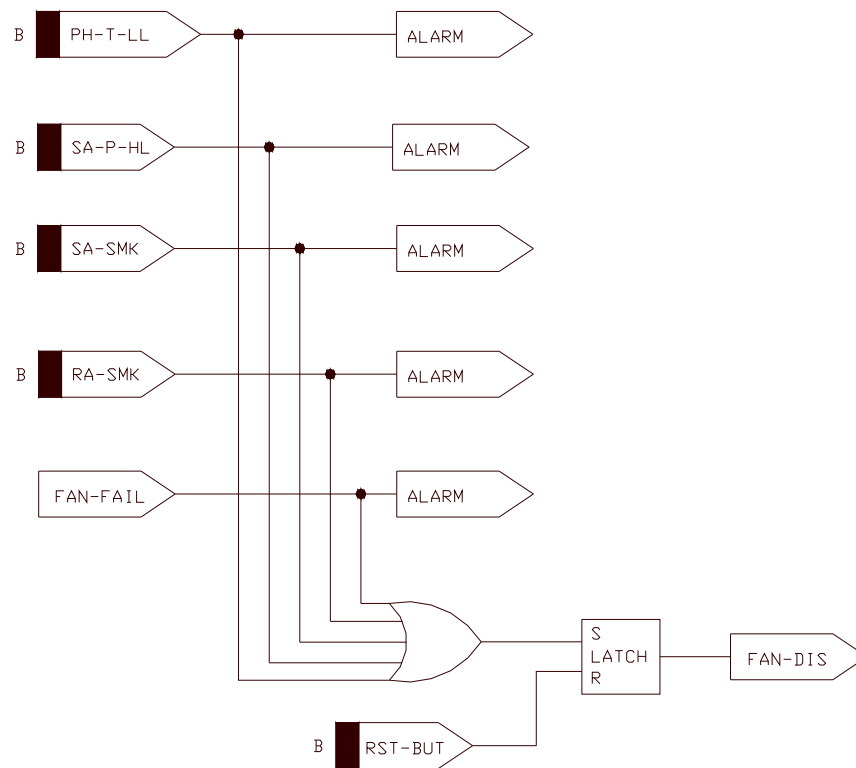


Figure 4-6. Alarms and Shutdown CLD.

4-4 CONTROL LOOPS

4-4.1 Preheat coil control loop

A minimum amount of outside air (OA) must always be used in HVAC systems. In cold climates preheating the OA avoids the freeze-up of coils and raises the temperature of the OA before using it in the system. Preheated OA is usually mixed in the return air plenum with a setpoint between 40° and 55°F depending on the application. For example, a 40°F setpoint might be used when there is a downstream coil to further condition the air while a 55°F setpoint might be used when there is no downstream coil. Figure 4-7 shows the preheat coil temperature loop schematic, and Figure 4-8 shows the CLD for preheat coil control. Designer selections for this loop include: (1) Preheat coil discharge air temperature setpoint (2) Preheat coil temperature low limit (PH-T-LL) (referred to as the Freeze stat) setpoint, (3) Valve size (C_v), (4) valve shutoff pressure/force, and (5) Control action of the controller. Note that the freeze stat is shown on the Preheat Coil Loop Control Schematic because that is **physically** where it is located and is shown on the Alarms and Shutdown CLD (not the Preheat Coil CLD) because that is where it is **logically** located.

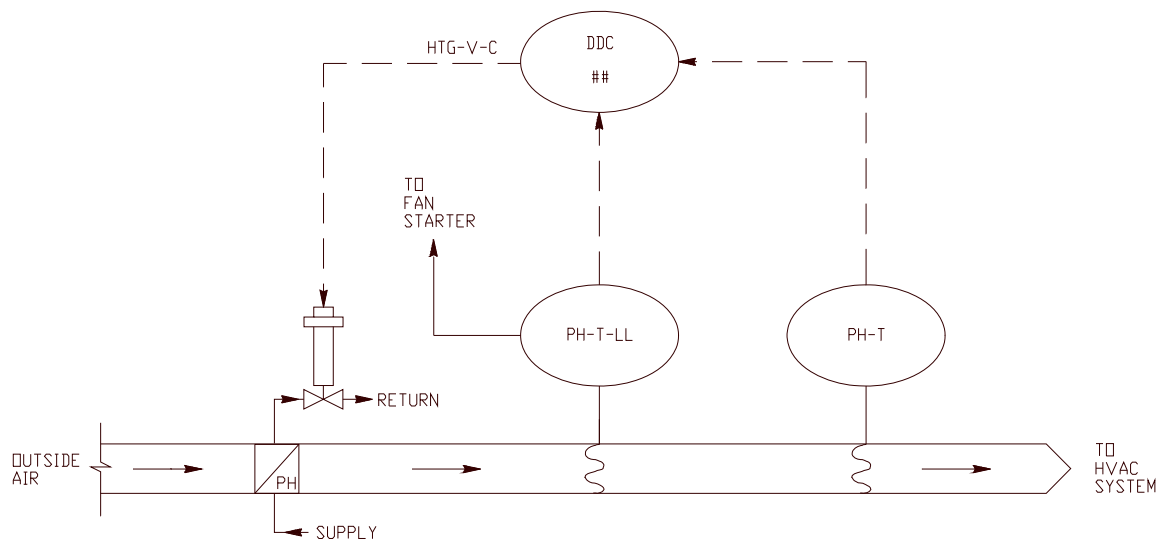


Figure 4-7. Preheat Coil Control Schematic.

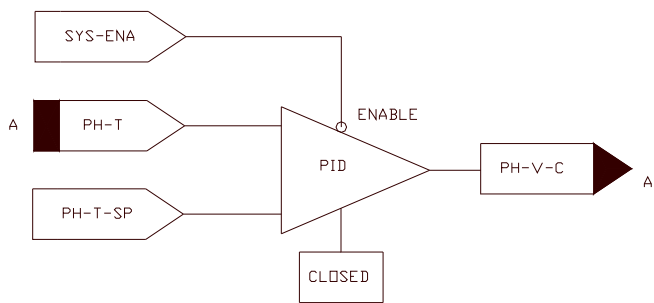


Figure 4-8. Preheat Coil CLD.

4-4.2 Cooling coil control loop

The cooling coil control loop is a constant-temperature control loop. The cooling coil valve is ordinarily chosen to be NC as an energy conservation measure and the corresponding control action will be DIR. As a failsafe against freezing, the designer might choose to select a NO valve with a corresponding REV control action (where if the AHU shuts down on freeze stat) since a fully open coil is less likely to freeze than a closed coil. A typical setpoint for the cooling coil control loop is 55°F, but will depend on the application requirements. In the event there is a mixed air temperature control loop, the cooling coil loop setpoint might be chosen to be slightly higher than the mixed air temperature setpoint. This slight difference in setpoints helps to keep the cooling coil valve closed while the mixed air temperature economizer is active. The cooling coil valve will open when the economizer loop does not maintain supply air temperature at or below the cooling coil loop setpoint. Figure 4-9 shows the cooling coil control loop schematic, and Figure 4-10 shows the CLD for cooling coil control. Ordinarily the control loop is enabled when: (1) the supply fan is proven to be on, and (2) the system is in the occupied mode. Note that the freeze stat is shown downstream of the cooling coil. This is to prevent false trips where upon system startup (such as at the beginning of the day) a surge of outside air is drawn into the air handler but after short amount of time becomes mixed with warmer return air. The designer may choose to locate the freeze stat upstream (such as in the mixed air section) particularly in the case where there is a heating coil upstream. In this case the cooling coil need not have a freeze stat but the heating coil should. As a rule, only one freeze stat is required per system. Designers are advised to check with local O&M staff for freeze stat location preferences. Suggested designer selections include the following: (1) Supply air temperature control setpoint (typical value of 55°F), and freeze stat setpoint in the Points Schedule; (2) Values for valve size (C_v) and valve shutoff pressure/force in the Valve Schedule; and (3) Control action notation in the Control Schematic Drawing.

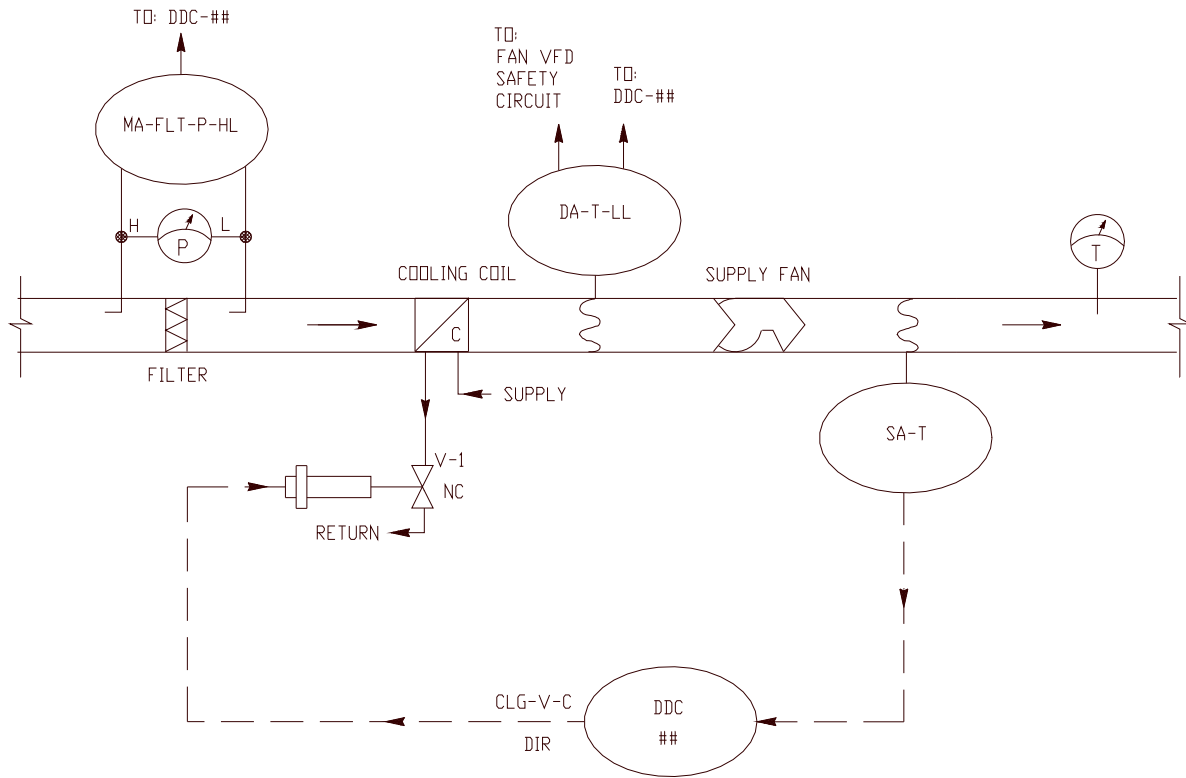


Figure 4-9. Cooling Coil Control Schematic.

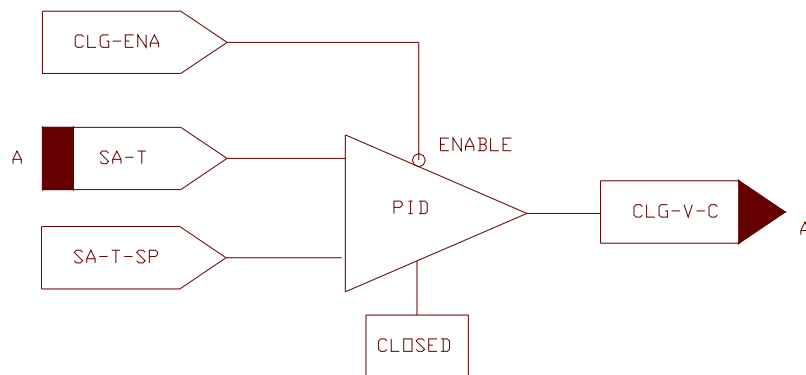


Figure 4-10. Cooling Coil CLD.

4-4.3 Heating coil control loop with setpoint reset

This control loop involves the control setpoint being adjusted (reset) based on a system variable (usually outside air temperature). Typical applications are (1) Heating hot water temperature (hydronic) and (2) Heating coil discharge air temperature.

A *reset schedule* defines the relationship between outside air temperature and setpoint temperature. Figure 4-11 shows an example of setpoint reset control, with the following characteristics: (1) heating coil discharge air temperatures of 120°F at 0°F outside air and below; (2) 90°F at 60°F outside air and above.

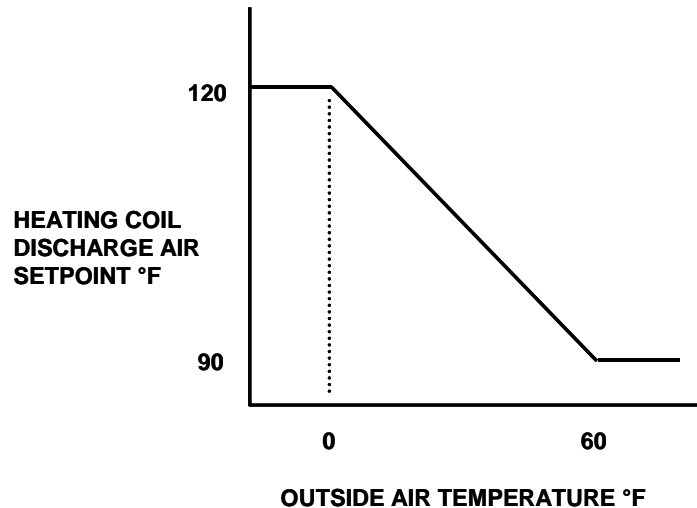


Figure 4-11. Typical Setpoint Reset Schedule for Heating Coil Air Temperature.

Figure 4-12 shows the heating coil with outside air reset control loop schematic. Suggested designer selections include the following: (1) Values for setpoint and freeze stat setpoint in the Points Schedule; (2) Reset Schedule, if setpoint reset is used; (3) Values for valve size (C_v) and valve shutoff pressure/force in the Valve Schedule; and (4) Control action notation in the Control Schematic Drawing.

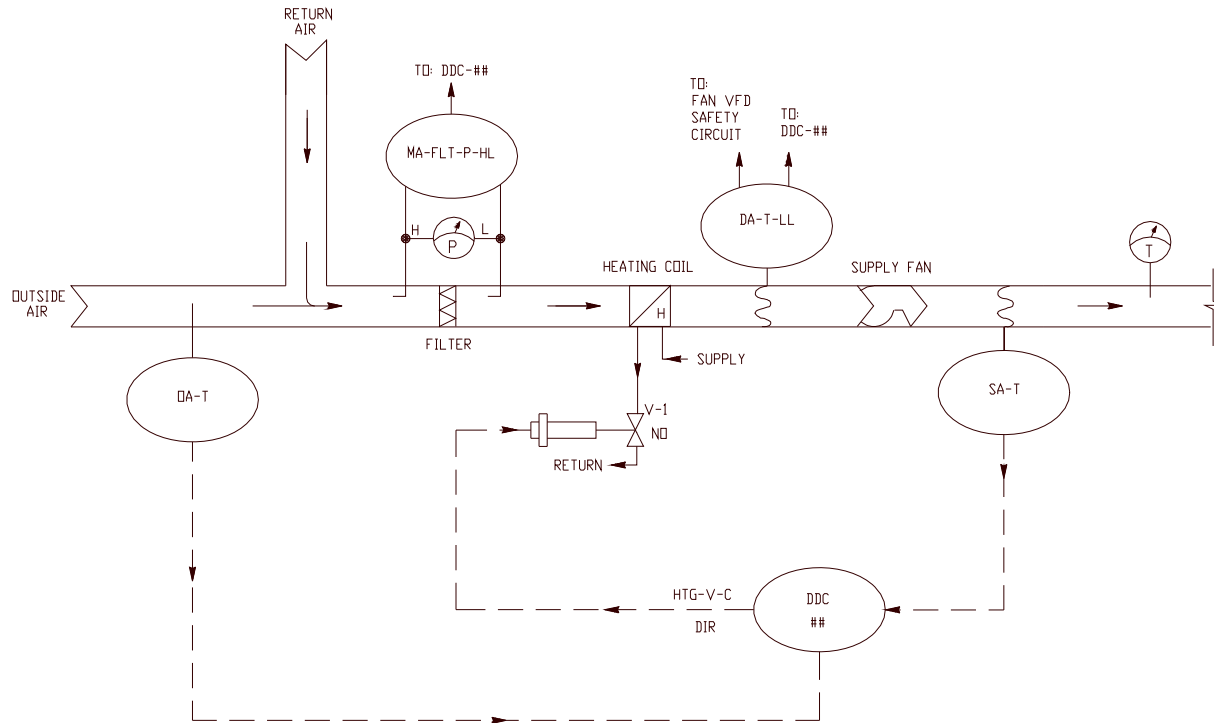


Figure 4-12. Heating Coil with Outside Air Reset Control Schematic.

4-4.4 Mixed air temperature control with economizer

An economizer functions as a switch to introduce outside air for “free cooling”. When the economizer is “on”, the mixed air temperature control loop DDC controller modulates the outside, return, and relief dampers. Modulation of the outside and return dampers regulates mixed air temperature (MA-T) to its specified setpoint while modulation of the relief damper serves to exhaust the additional outside air delivered to the building/spaces. When the economizer is “off” the economizer outside air damper is closed.

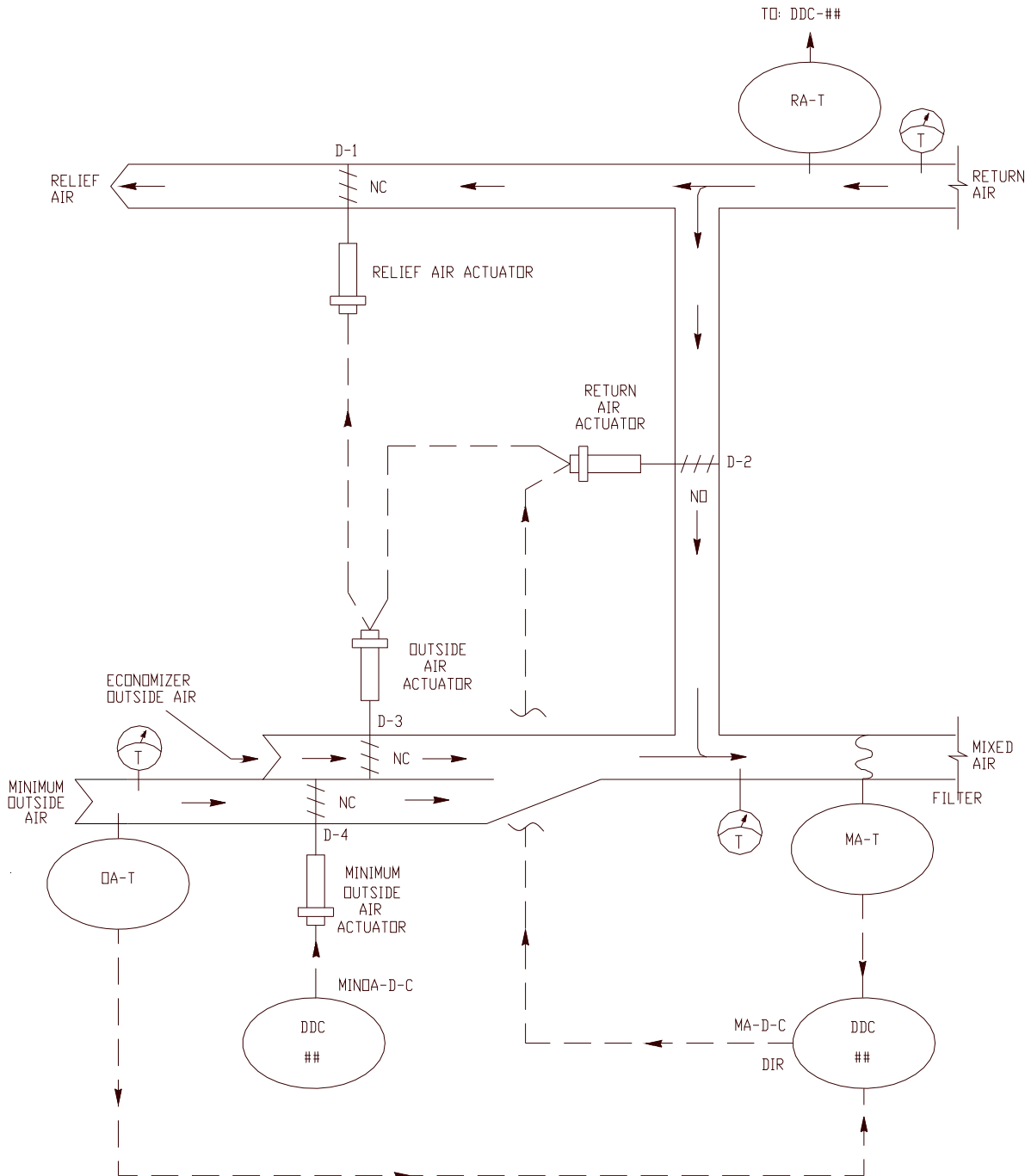
UFC 3-410-02**19 Nov 2008**

Figure 4-13. Economizer/Mixed Air Temperature Control Schematic.

4-4.4.1 OA-Only dry bulb economizer

Although there are many ways to perform the economizer on/off decision, a control system that uses only an outside air dry bulb sensor is recommended based on its simplicity and long term reliability as compared to other methods.

Figure 4-13 shows the OA-only dry bulb economizer control loop. It uses an OA dry bulb sensor and DDC controller to make the economizer on/off decision. When the Economizer is on, the controller sends a mixed air damper command (MA-D-C) to modulate the relief, return, and outside air dampers. When the economizer is off, the DDC moves the three dampers to their failsafe positions. Minimum outside air quantity is maintained by a separate control loop. The return air temperature sensor shown in figure 4-13 is optional and would be used only for temperature monitoring purposes.

Figure 4-14 shows the CLD for the OA-only dry bulb economizer. As described previously, the System Enabling Logic provides the SYS-ENA signal (based on occupied mode and fan proof). When the outside air temperature is less than the economizer high limit setpoint (ECO-HL-SP) a 'true' output is generated by the comparator (COMP). Similarly, when outside air temperature is greater than the economizer low limit setpoint (ECO-LL-SP) a true output is generated by the other comparator (COMP). When all three conditions are true the AND gate generates a true output enabling the MA-T PID loop. When the PID is not enabled the default output closes the OA economizer damper.

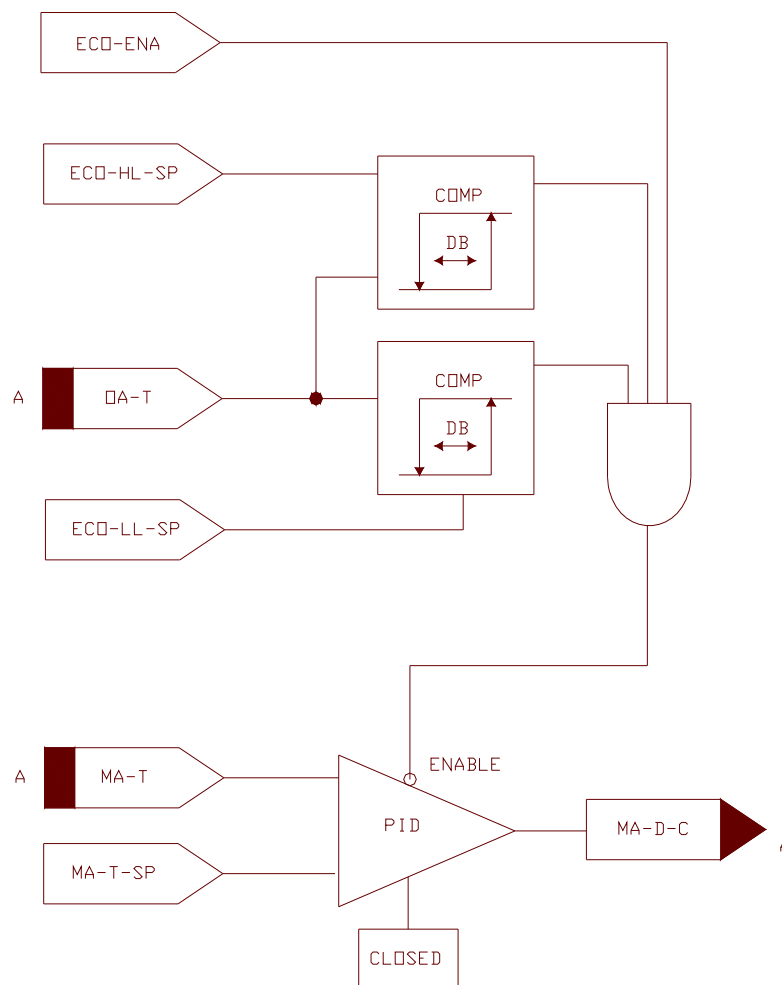


Figure 4-14. OA-Only Dry Bulb Economizer CLD.

4-4.4.2 OA-Only dry bulb economizer designer selections

The designer must select the economizer high limit setpoint (ECO-HL-SP), the low limit temperature setpoint (ECO-LL-SP), and the mixed air temperature setpoint (MA-T-SP).

4-4.4.2.1 Economizer high limit setpoint selection

Economizer high limit setpoint (**ECO-HL-SP**) is the dry bulb temperature below which the OA-only economizer turns “on”. The objective is to select it low enough so that the economizer turns on when the OA enthalpy is lower than the return air enthalpy, thus achieving free cooling. Since neither the return air enthalpy nor outside air enthalpy are being measured, assumptions must be made. Outside air enthalpy can be estimated based on the outside air dry bulb temperature using (local) average weather data. The ECO-HL-SP is then selected based on this estimation. Due to the assumptions made a margin of safety is then applied to the selection of ECO-HL-SP.

Figure 4-15 illustrates selection of the **OA-only economizer** setpoint for Greenville, NC:

1. Plot a constant enthalpy line through the return air design dry bulb temperature & relative humidity (A-B). In this example, 78°F and 50% RH. Caution: Give careful consideration to the return air condition. For example, if you follow this procedure for 78°F and 50% RH condition but the actual condition is 72°F and 50% RH, the economizer (on average) will turn on about 4°F or 5°F sooner than it should, resulting in wasted mechanical cooling energy.
2. Plot a weather line (C-D) for the worst case month, in this case July, using the midpoint of each OA dry bulb bin and corresponding mean coincident OA wet bulb. To help select the worst case month, you may choose to plot the average weather line for two or three summer months and then proceed to step 3. Wet bulb and dry bulb weather data is available through UFC 3-400-02 "Design: Engineering Weather Data" which references a data download site at <http://www.afccc.af.mil>.
3. Draw a vertical line down from the intersection of lines A-B and C-D to the dry bulb axis. This is Point E. (If you plotted multiple average weather lines, draw the vertical line down from the month that places Point E furthest to the left.)
4. For the **OA-only economizer**, the economizer high limit setpoint (ECO-HL-SP) is point E, or 67°F. Again, note the additional caution in step 1.

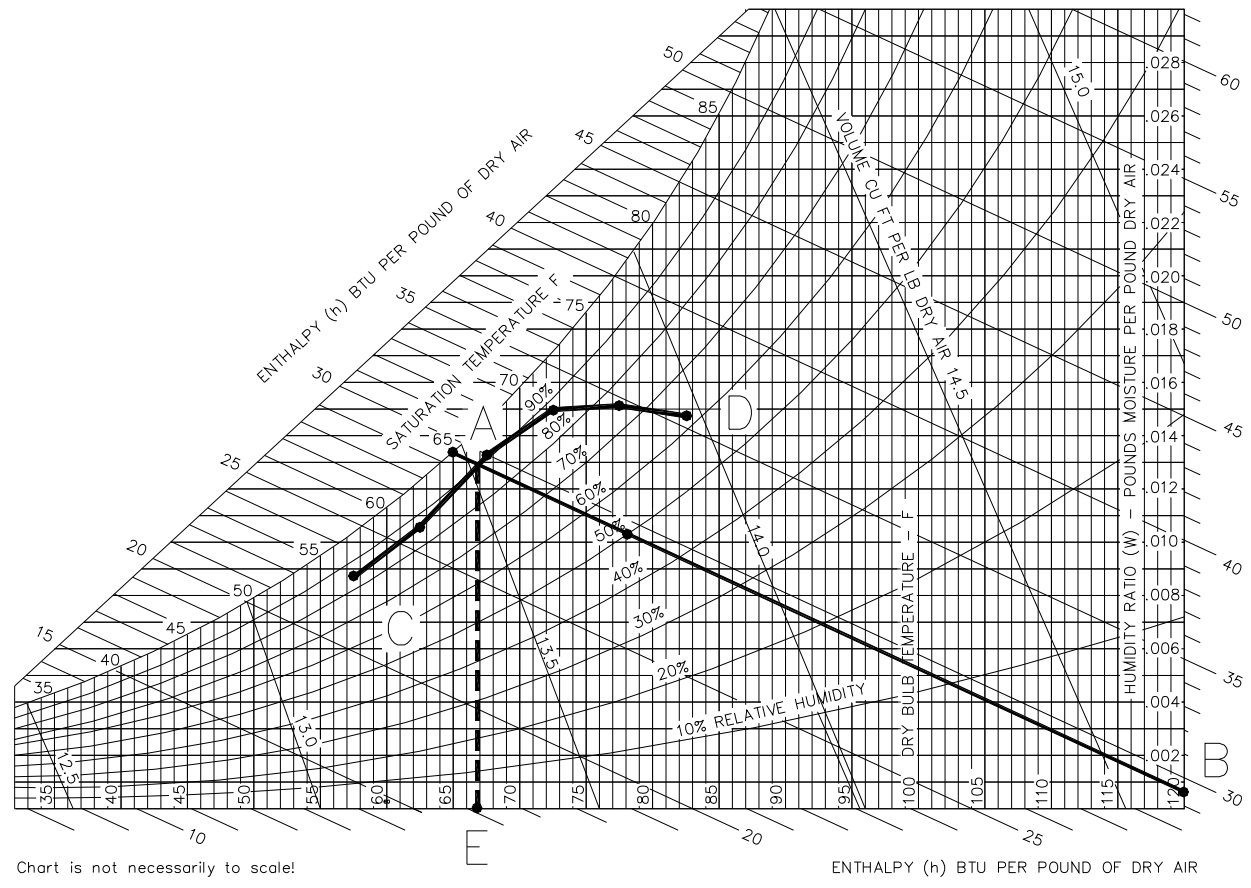


Figure 4-15. OA-Only Economizer Setpoint Selection Example for Greenville, NC.

UFC 3-410-02**19 Nov 2008**

GREENVILLE-SPARTANBURG APRT SO CAROLINA

LAT 34 54N LONG 82 13W ELEV 957 FT

MEAN FREQUENCY OF OCCURRENCE OF DRY BULB TEMPERATURE (DEGREES F) WITH MEAN COINCIDENT WET BULB TEMPERATURE (DEGREES F) FOR EACH DRY BULB TEMPERATURE RANGE

Temperature Range	MAY				JUNE				JULY				AUGUST				SEPTEMBER				OCTOBER			
	Obsn Hour Gp		Total Obsn	M C	Obsn Hour Gp		Total Obsn	M C	Obsn Hour Gp		Total Obsn	M C	Obsn Hour Gp		Total Obsn	M C	Obsn Hour Gp		Total Obsn	M C	Obsn Hour Gp		Total Obsn	M C
	01 to 08	09 to 16	17 to 24	W B	01 to 08	09 to 16	17 to 24	W B	01 to 08	09 to 16	17 to 24	W B	01 to 08	09 to 16	17 to 24	W B	01 to 08	09 to 16	17 to 24	W B	01 to 08	09 to 16	17 to 24	W B
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95/99	0			0 69	3	1	4 74		2	1	3 74		0		0 75		1		1 73					
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70/74	25	43	62	130 64	74	31	67 172 67		152	17	66 235 69		134	19	57 210 69		70	44	66 180 67		4	44	27 75 62	
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Figure 4-16. Greenville SC Weather Data for OA-Only Economizer Setpoint Selection Example.**4-4.4.2.2 Low limit temperature setpoint selection**

Economizer low limit setpoint (**ECO-LL-SP**) is the dry bulb temperature below which the OA-only economizer turns 'off' when the OA temperature is cool/cold (e.g. 50°F). As a practical matter, while the economizer is 'on', the mixed air control loop will modulate the dampers to maintain the mixed air setpoint. Therefore this low limit function is theoretically not needed, but it can help prevent nuisance tripping of the freeze stat and can also help stabilize the minimum outside air flow control loop by eliminating interaction between these two competing airflow paths. Selection of the ideal setpoint selection would require modeling to identify the heat/cool *balance point* of the building where, below the balance point, the building only needs heating. Modeling can be expensive and therefore not practical. An estimate of the ECO-LL-SP (balance point) is acceptable, usually 50°F. Applications with high internal cooling loads may benefit from a lower setting.

4-4.4.2.3 Mixed air temperature setpoint selection

The mixed air temperature setpoint (MA-T-SP) should be selected to be the same as the cooling coil control loop discharge air setpoint (CC-DA-T-SP), typically 55°F, or 1°F to 2°F less than CC-DT-SP. A lesser setpoint helps to reduce or eliminate mechanical cooling while the economizer is 'on'.

4-4.4.3 OA/RA dry bulb economizer

The OA/RA dry bulb economizer is a refinement of the OA-only economizer in that it takes into account the return air condition by sensing return air dry bulb. This economizer should be used with caution but can be beneficial where the return air condition is not constant such as in variable load and/or variable occupancy applications. More importantly, proper operation is highly dependent upon seasonal changes in space temperature setpoints in that heating mode space setpoints must be lower than cooling mode space setpoints. This is further discussed as part of the Condition 2 setpoint selection.

Figure 4-13 and Figure 4-17 illustrate the OA/RA dry bulb economizer. Unlike the OA-only economizer the OA/RA economizer uses both the outside and return air temperature sensor measurements. It operates when *both* of two temperature conditions are met:

1. Condition 1: The difference between return and outdoor air temperatures (RA-T and OA-T, respectively) is sufficient to use OA for free cooling. Specifically, RA-T minus OA-T is greater than the economizer differential setpoint (ECO-DIFF-SP)
2. Condition 2: RA-T indicates that there is a cooling load. Specifically, RA-T is greater than the ECO-HL-SP. Note that RA-T is not the only mechanism by which the economizer can determine if there is a cooling load. The designer may choose an alternate mechanism such as the status of the cooling coil valve position (where if it is not closed, Condition 2 is met).

In addition, as described previously, the economizer enable (ECO-ENA) signal must be 'true'. This signal is generated by the System Enabling Logic (when the system is in occupied mode and supply fan proven 'on').

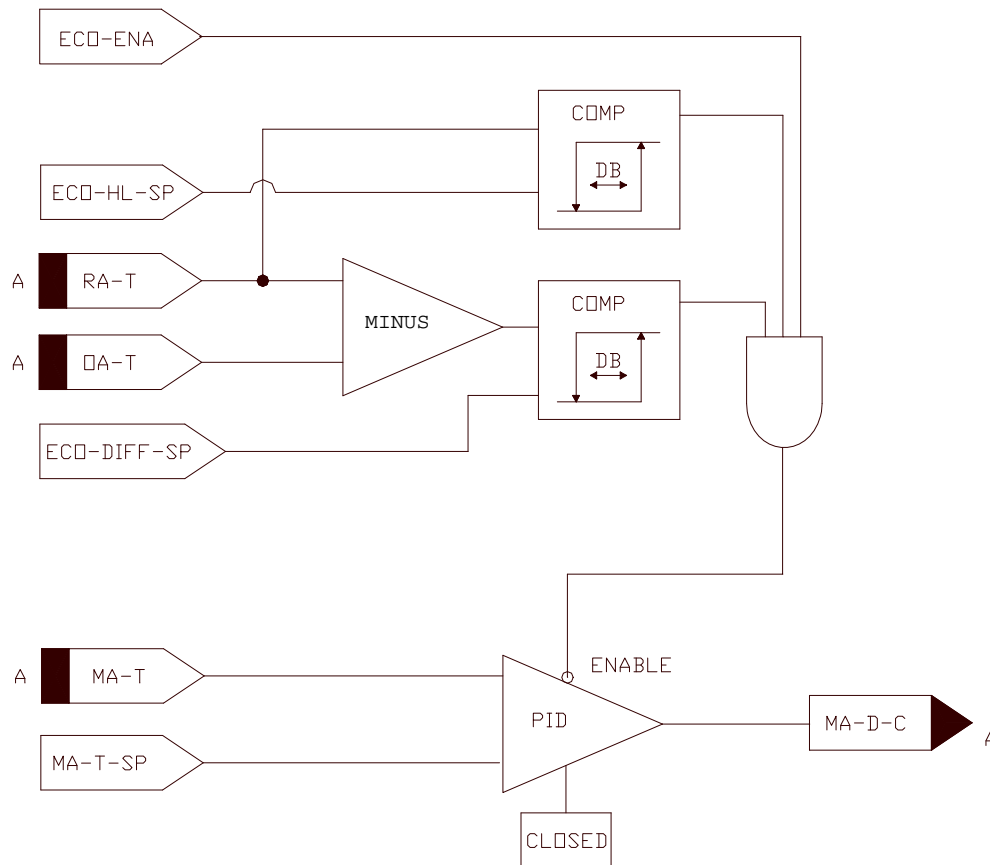


Figure 4-17. Mixed Air Temperature Control with RA/OA Activated Economizer CLD.

4-4.4.4 OA/RA dry bulb economizer designer selections

The designer must select the ECO-DIFF-SP and the ECO-HL-SP.

4-4.4.4.1 OA/RA economizer differential setpoint selection

Selection of the switching 'Condition 1' ECO-DIFF-SP is based on annual average (wet bulb) weather data which takes enthalpy into account, thereby optimizing the dry bulb economizer's on/off decision. In summary, the designer uses a psychrometric chart and BIN weather data to correlate OA enthalpy to OA dry bulb along with an assumed RA condition (%RH and dry bulb) to correlate RA enthalpy to RA dry bulb. This results in a measure of OA and RA *dry bulb* temperatures that, in effect, provides for an enthalpy-based economizer decision.

Figure 4-18 illustrates selection of the OA/RA economizer Condition 1 setpoint (ECO-DIFF-SP) for Greenville, NC using weather data shown in Figure 4-16:

UFC 3-410-02**19 Nov 2008**

1. Plot a constant enthalpy line through the return air design temperature & relative humidity (A-B). In this example, 78°F and 50% RH.
2. Plot the average weather line (C-D). Use the midpoint of each OA dry bulb bin and corresponding mean coincident OA wet bulb from TM-5-785.
3. Draw a vertical line down from the intersection of lines A-B and C-D. This is point E.
4. Draw vertical line (G) down from constant enthalpy line return air condition to dry bulb temperature.
5. The **OA/RA economizer ECO-DIFF-SP** is the difference between point E and point G.

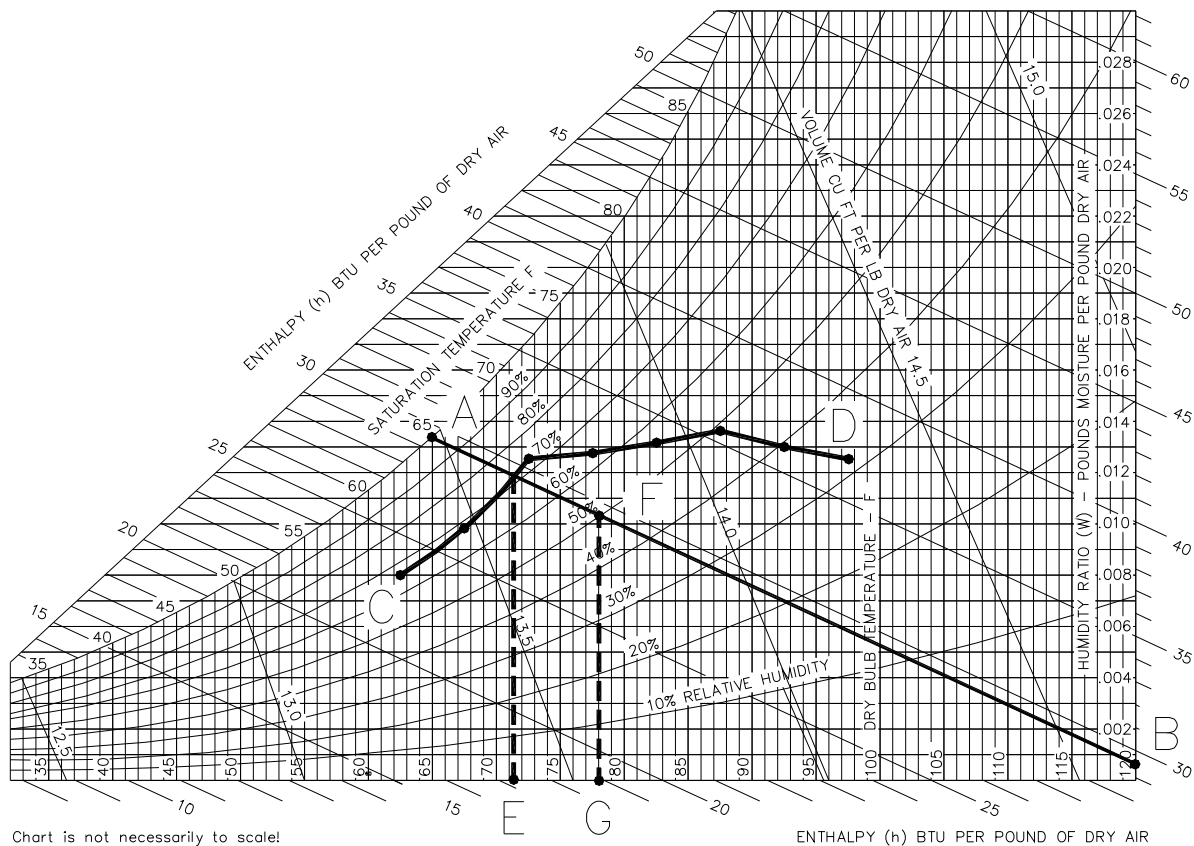


Figure 4-18. OA/RA Economizer Differential Setpoint Selection.

UFC 3-410-02**19 Nov 2008**

GREENVILLE-SPARTANBURG APRT SO CAROLINA

Tempera ture Range	NOVEMBER				DECEMBER				JANUARY				FEBRUARY				MARCH				APRIL				ANNUAL TOTAL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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Figure 4-19. Greenville SC Weather Data for OA/RA Economizer Setpoint Selection Example.

4-4.4.4.2 OA/RA economizer high limit setpoint selection

Selection of the switching 'Condition 2' ECO-DIFF-SP, and thus proper operation of this economizer, is premised on the **assumption** that the return air temperature will vary based on the need for heating or cooling and, to a lesser extent, based on load changes. In other words, there must be a seasonal swing in the return air temperature. This swing can be achieved by defining and implementing zone/space heating and cooling thermostat setpoints (i.e. 68°F heating and 78°F cooling). If this is not desirable or achievable, the OA/RA dry bulb economizer is not recommended. With a heating mode setpoint of 68°F and a cooling mode setpoint of 78°F, the midpoint is 73°F. To account for return air heat pickup from lights and other sources, add 2°F to this midpoint. The ECO-HL-SP setpoint is then 75°F.

4-4.4.4.3 Mixed air temperature setpoint selection

The mixed air temperature setpoint (MA-T-SP) should be selected to be the same as the cooling coil control loop discharge air setpoint (CC-DA-T-SP) (typically 55°F) or 1°F to 2°F less than CC-DA-T-SP. This lower setpoint helps to reduce or eliminate mechanical cooling while the economizer is 'on'.

4-4.5 Outside air flow control

This section describes the three preferred methods that may be used to accomplish outside air flow control:

- 1) Two-Position Damper
- 2) Flow Control
- 3) Demand Controlled Ventilation

In each case, a separate/dedicated ventilation outside air duct should be specified. A dedicated duct provides for a more accurate setting and better control of the outside air flow. 100% outside air systems and systems that do not contain an economizer do not require this separate/dedicated duct.

The control system design must be accomplished in accordance with ASHRAE Standard 62, "Ventilation for Acceptable Indoor Air Quality", which describes how to provide indoor air quality that will be acceptable to human occupants and is intended to minimize the potential for adverse health effects. Standard 62 also contains guidance on managing sources of contamination, controlling indoor humidity, and filtration of the building air.

4-4.5.1 Ventilation air versus make-up air

Design of the outside air flow control loop and the specified minimum outside air (MINOA) flow quantity must take into account two basic considerations;

- 1) Ventilation air for building occupants, and
- 2) Make-up air required to offset building exhaust and to provide pressurization for exfiltration flow

The MINOA quantity selected by the designer must be sufficient to meet the ventilation air flow requirements as defined in ASHRAE Standard 62. In addition, the minimum outside air quantity must be sufficient to provide make-up air for all sources of exhaust flow (Exh Flow) from the areas served by the air handler and to provide for a degree of building pressurization by creating exfiltration flow (Exf Flow). The larger of these two outside air quantities should be selected and specified as the MINOA quantity. In summary:

If Ventilation Air Flow > (Exh Flow + Exf Flow), then: MINOA = Ventilation Air Flow

If Ventilation Air Flow < (Exh Flow + Exf Flow), then MINOA = Exh Flow + Exf Flow

The exfiltration flow component is intended to help ensure that the MINOA flow exceeds the building exhaust flow. This in turn helps to create a positive pressure in the zones/spaces served by the air handler. Exact calculation of the exfiltration flow that is required to create positive building pressure is a non-exact science due to uncertainty in inter-zonal flows and year round variations in wind-induced pressure on the external

surfaces of the building. It can be estimated using special computer programs, the ASHRAE crack method, or ASHRAE air exchange method. Alternatively, the exfiltration flow can be estimated to be a small fraction (5 to 10%) of the total design flow.

4-4.5.2 Two-position damper

This scheme applies to constant volume systems such as multizone and single zone air handlers. It can also be used in 100% outside air systems where there is only a single OA duct. Figure 4-20 shows a CLD for minimum OA damper control using a two-position damper.

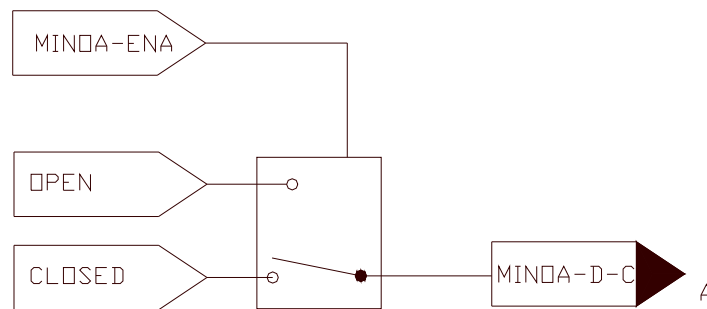


Figure 4-20. Minimum OA Using Two-Position Damper CLD.

4-4.5.3 Flow control

This scheme applies to variable air volume systems. This approach helps to ensure that the specified outside air quantity is supplied to the system/zones as supply fan capacity modulates with changes in VAV terminal unit flows. A minimum outside air flow (MINOA-F) sensor senses flow in the MINOA duct and is controlled to the specified setpoint through modulation of the MINOA damper using a PID controller. Figure 4-21 shows a CLD for MINOA flow control using fixed OA flow.

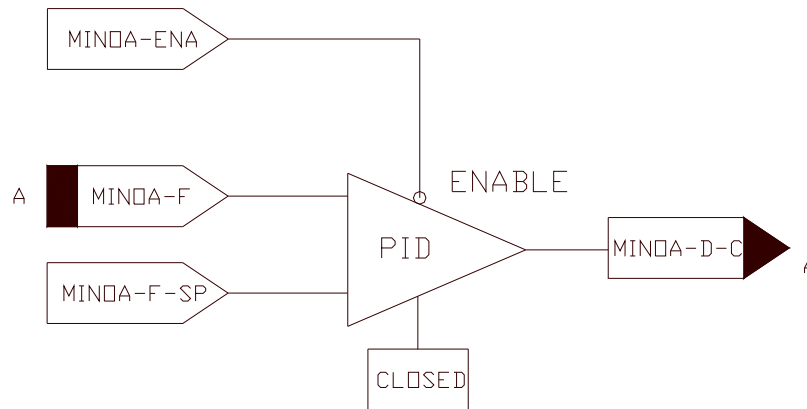


Figure 4-21. Minimum OA Flow CLD.

4-4.5.4 Demand controlled ventilation

A demand controlled ventilation (DCV) strategy adjusts ventilation air to a building or zone to meet occupant needs and to provide for odor control. It can also save energy by minimizing ventilation loads.

ASHRAE Standard 62.1-2004 describes adjustment of the HVAC system to “reset the design outdoor air intake flow and/or space or zone airflow as operating conditions change.” Standard 62.1-2004 lists examples of dynamic reset strategies including reset based on occupancy such as an occupancy schedule, occupancy sensors, or carbon dioxide (CO₂) sensors.

CO₂ based DCV uses CO₂ sensor(s) to predict the demand where contaminant levels result primarily from people and occupancy varies significantly (barracks, mess halls, conference facilities, gyms, and auditoriums). Leadership in Energy and Environmental Design (LEED) points can be awarded for use of a demand control strategy.

4-4.5.4.1 Demand controlled ventilation design

The design of a CO₂-based DCV control strategy should be in accordance with the standards and procedures described in ASHRAE Standard 62.1. Standard 62.1-2004 requires that spaces with a design occupancy density greater than 100 people per 1000 ft² incorporate DCV in the HVAC design (i.e. lecture halls, auditoriums, lobbies). Standard 62.1-2004 also includes guidance on maintenance that the designer should consider and include in the project specifications.

The DCV strategy should adjust the outside air (OA) flow quantity based on the sensed CO₂ concentration while also limiting the outside air flow quantity (to a minimum and maximum quantity). The DCV control loop must be designed and specified such that the system modulates between the upper limit of “minimum OA” and lower limit of “minimum OA.” The HVAC system must be sized to accommodate the ventilation load. The use of a DCV strategy applies to variable air and constant volume systems.

The OA flow damper should be located in a dedicated minimum OA flow duct and modulated to control the OA flow quantity. Flow control is accomplished by simple damper positioning in a constant volume system and by an air flow measurement station (AFMS) in a VAV system. Two-position dampers are unacceptable in a VAV system.

4-4.6 Variable air volume control loops

A variable air volume (VAV) system has the following unique characteristics:

- The air-handling unit (AHU) serves multiple zones with a single duct that delivers cool air. Sometimes the AHU will have a small preheat coil.
- Each zone has a VAV box (terminal unit) for temperature control. Each VAV box has a thermostat. VAV box dampers modulate for cooling. Heating may be provided by a reheat coil or electric resistance heating element inside the VAV box with the dampers at a minimum airflow position.
- VAV boxes open and close causing total air volume to vary.
- The AHU fan capacity varies to keep the duct pressure constant.

4-4.6.1 Supply duct static pressure control loop

In a supply duct static pressure control loop, the supply fan capacity modulates to maintain a constant duct static pressure while the VAV boxes are opening and closing. Each VAV box needs a minimum amount of static pressure to operate properly and to deliver the required amount of air to its zone. There are two methods of supply fan capacity control: (1) using a variable speed fan (recommended) and (2) inlet guide vanes. Figure 4-22 shows the supply duct static pressure control loop schematic while Figure 4-23 shows the CLD for supply duct static pressure control.

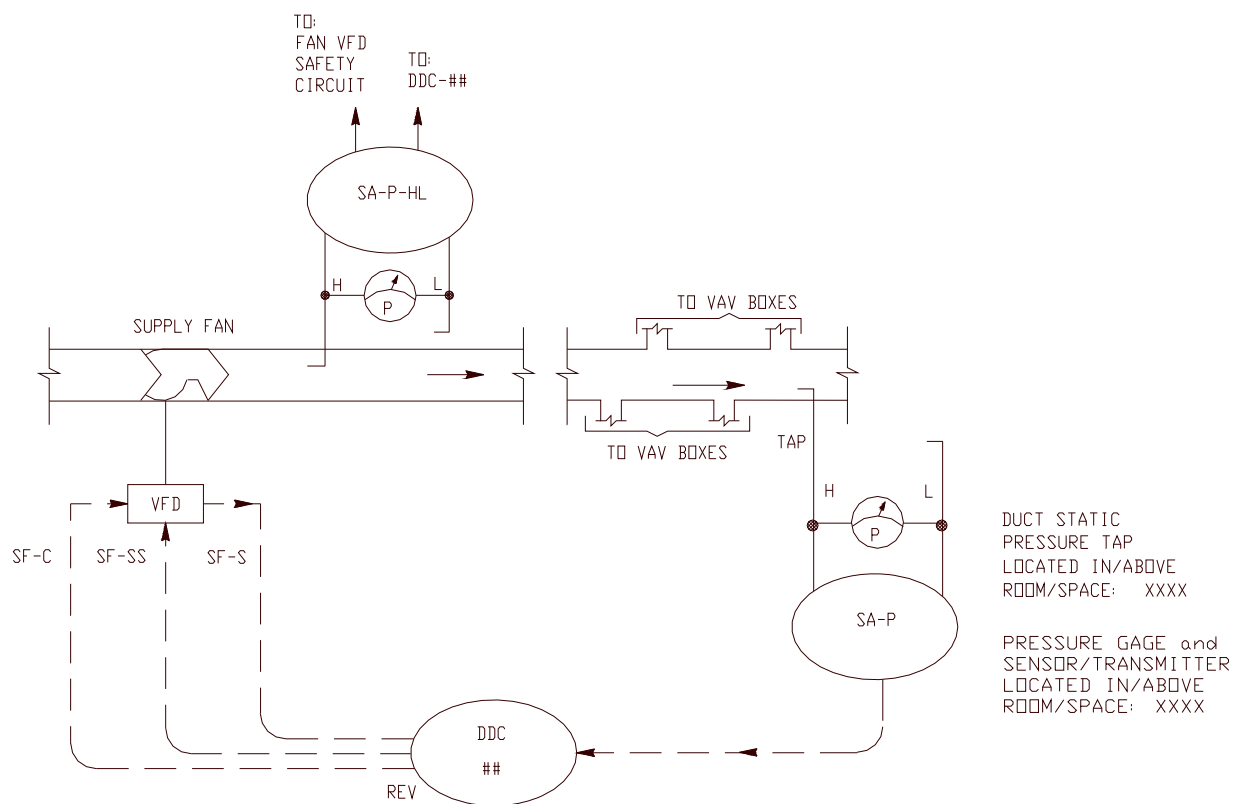


Figure 4-22. Supply Duct Static Pressure Control Schematic.

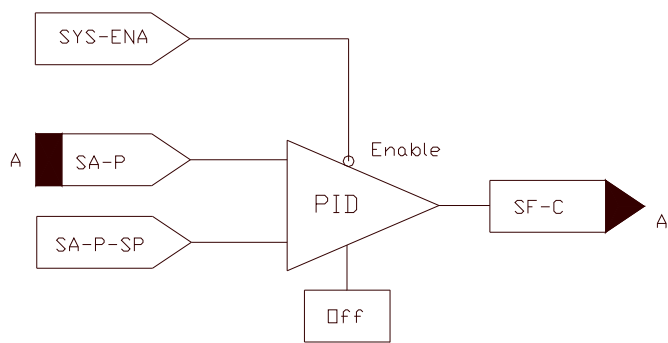


Figure 4-23. Supply Duct Static Pressure CLD.

Suggested designer selections include the following: (1) Value for supply duct static pressure setpoint (SA-P-SP) in the Points Schedule (typically 1 inch of water column (iwc)); (2) Value for duct static (differential) pressure sensor range (typically 0 to 2.5 iwc); (3) Value for duct static high-limit setpoint based on duct pressure class; and (4) Control action notation in the Control Schematic Drawing.

4-4.6.2 Supply duct static pressure control loop with setpoint reset

In accordance with ASHRAE standard 90.1, a variation on the basic supply duct static pressure loop is where the setpoint is adjusted based on VAV box demand. The commanded position of each VAV box damper is used to determine demand.

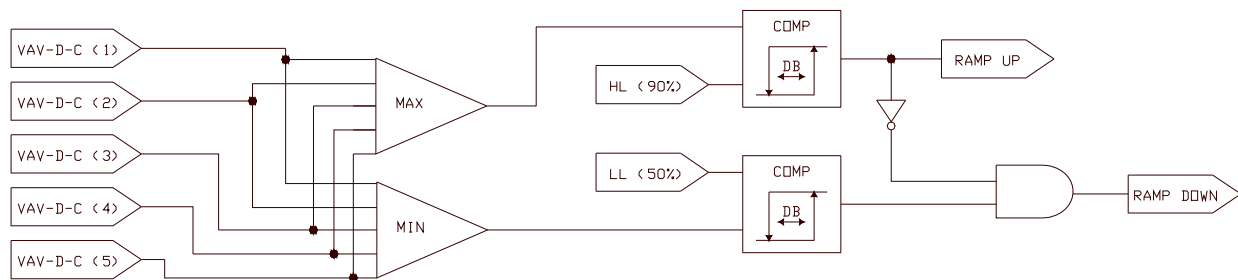


Figure 4-24. Supply Duct Static Pressure Setpoint Reset.

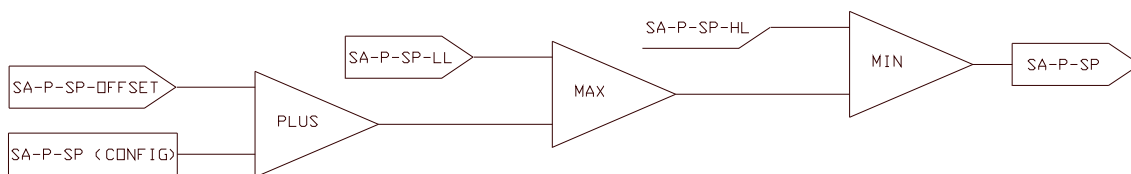


Figure 4-25. Supply Duct Static Pressure Setpoint Reset, Setpoint Calculation.

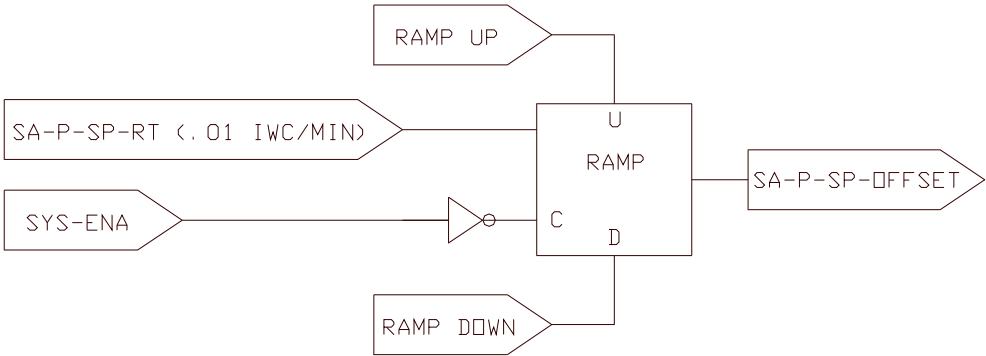


Figure 4-26. Supply Duct Static Pressure Setpoint Reset, Ramp-up / Ramp-down.

4-4.6.3 VAV box control

4-4.6.3.1 VAV box categories

VAV boxes must be of the pressure independent variety. The four basic types include; cooling only, cooling with reheat, series fan-powered, and parallel fan-powered.

4-4.6.3.2 Occupancy mode control

The sequence of operation will describe the control-related functions of each VAV box including Occupied and Unoccupied modes. Control of the occupancy mode is based on a System Scheduler or an occupancy input device:

- **System Scheduler.** The SNVT input from a System Scheduler (DDC Hardware) commands the VAV box to operate in either the occupied or unoccupied mode. Note that VAV boxes do not operate in a warmup or cooldown mode. Instead, they are commanded to operate in the Occupied Mode when their servicing AHU has been instructed by the System Scheduler to operate in warmup/cooldown mode. System Scheduling is described elsewhere in this UFC.
- **Occupancy input device.** The space/zone occupancy input from either an occupant accessible pushbutton or space mounted occupancy sensor indicates that the space is occupied. This occupancy input is used to override the system into occupied mode (usually during a scheduled unoccupied time period). When the pushbutton override input is used, the designer should decide/select how long the override will last (because this is a software feature) whereas the sensor override input is dependent upon the occupancy sensor hardware. This too can be selected/specified but requires editing of the sensor specification in the UFGS.

In Occupied Mode the zone temperature setpoint (ZN-T-SP) operates at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat where the configured setpoint is a fixed setting that resides in memory of the DDC hardware and is shown by the designer in the Points Schedule. Ordinarily the zone (occupied) temperature setpoint (ZN-T-SP) will come from an occupant-adjustable wall-mounted thermostat (via a slidey bar or knob at the thermostat). However there are some cases (computer room, museum, etc.) where the setpoint should be configured and not adjustable via a thermostat. The designer edits the sequence of operation to select the occupied mode condition(s) based on the application and project specific requirements.

In the Unoccupied Mode the zone temperature setpoint (ZN-T-SP) is at the configured unoccupied mode setpoint (instead of the thermostat setpoint). Note that a cooling-only VAV box does not have an Unoccupied Mode ZN-T-SP. It simply moves its damper to minimum position.

Sequencing diagrams should be included to illustrate the zone temperatures at which VAV box devices such as valves, dampers, fans, and heating elements turn on and off and/or open and close.

4-4.6.3.3 VAV box control - designer selections

Most designer selections will be shown in the Thermostat and Occupancy Sensor Schedule drawing as shown in Figure 5-3. Some settings will be shown in the Points Schedule drawing. Designer selections for VAV box control include the following:

- (1) Thermostat location (particularly room number) to be shown in the schedule,
- (2) Whether or not the temperature setpoint is to be adjustable at the thermostat,
- (3) Occupied and unoccupied mode setpoints,
- (4) Unoccupied mode override (occupant accessible push button),
- (5) Unoccupied mode override (occupancy sensor),
- (6) Valve size (Cv) in the case of a box containing a coil, and
- (7) VAV box sequencing including a deadband between heating and cooling modes and the minimum and maximum airflow setpoints. Ordinarily, the minimum and maximum flow setpoint quantities are shown in a separate mechanical system drawing, not a control drawing.

4-4.6.4 Return fan control loop

A return fan in a VAV system is inherently difficult to control. Therefore, designers should avoid them where possible by using short or large return ducts and plenum instead of ducted returns. A return fan helps to ensure proper air distribution and may be required if the return air duct section pressure drop (between the zone and the relief damper) is excessive or if the supply fan inlet head will prevent positive pressure from being created at the air handler relief. Excessive return duct pressure drop can result in the following: (1) Over-pressurization of zone and excessive exfiltration as the supply air seeks an exit path out of the zone; (2) Inadequate supply air flow at the design condition due to zone and return duct flow resistance; (3) Air being drawn in through the AHU relief duct (not exhausted); or (4) The need for a return fan.

4-4.6.4.1 Return fan control techniques

4-5.8.3.1.1 Flow matching

Flow matching is accomplished by measuring the supply and return air duct flow rates using airflow measurement devices/arrays and controlling the return duct flow by modulating the return fan capacity.

4-5.8.3.1.2 Direct building pressurization

Direct building pressurization is accomplished by measuring the building/space pressure using a differential pressure sensor (referenced to outdoors) and modulating the capacity of the return fan.

4-5.8.3.1.3 Fan matching

Fan matching is accomplished by sending a control signal to the return fan identical to that used to modulate the capacity of the supply fan. Ordinarily, the signal sent to the return fan is offset or characterized in some fashion so that the return duct flow is less than the supply duct flow.

4-4.6.4.2 Flow matching return fan control loop

Of the three primary techniques for controlling a return fan in a VAV system, flow matching is recommended. Flow matching uses air flow measurement devices in the supply and return air ducts and the control loop maintains a constant flow difference between the supply and return air ducts. When more air is supplied than returned, this tends to pressurize the building or zones. Matching air flows also helps ensure proper air distribution through the air handler outside air intake and relief. Figure 4-27 shows a return fan flow control loop schematic, and Figure 4-28 shows the CLD.

19 Nov 2008



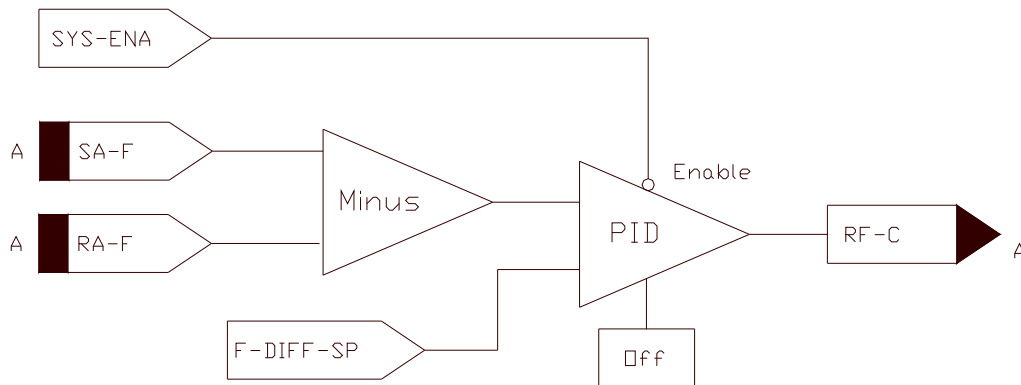


Figure 4-28. Return Fan Flow CLD.

4-4.6.4.3 Flow difference setpoint (F-DIFF-SP) selection

The designer must select the Flow Difference Setpoint (F-DIFF-SP) for the flow matching control loop:

$$\text{F-DIFF-SP} = \text{Flow}_{\text{exh}} + \text{Flow}_{\text{exf}}$$

Eq. 4-1

Where:

Flow_{exh} = Zone exhaust flow, cfm or L/s

Flow_{exf} = Zone exfiltration flow, cfm or L/s

Figure 4-29 illustrates these flows.

Flow_{exh} is the total of all zone exhaust fan flows.

Flow_{exf} is selected to create a degree of pressurization in the zone by forcing air to exfiltrate from the zone. Theoretically, zone pressurization will occur with only the slightest amount of exfiltration flow but, due to limitations in flow sensor and controller accuracy, Flow_{exf} should be selected as 7 to 10 percent of the design supply flow. This helps ensure that supply flow will be greater than return flow. In addition, depending on the need in the application to ensure pressurization, the designer might choose to increase Flow_{exf} . As rules of thumb: $\text{Flow}_{\text{exf}} = 10\%$ of design flow (for **tight** buildings) and 20% of design flow (for **drafty** buildings). The following cautions apply to these “rules of thumb”:

1. The zone(s) on the windward side of the building may be overcome by external wind pressure on the building surface. A 17 mph wind induces an external velocity pressure on the face of the building of approximately 0.1 in. wc (25 Pa) and can result in air infiltration. A larger bias flow may not counteract external wind pressure (i.e. the excess bias flow may exfiltrate out of the downwind side of building or be exhausted by exhaust fans or migrate to other zones/air handlers).

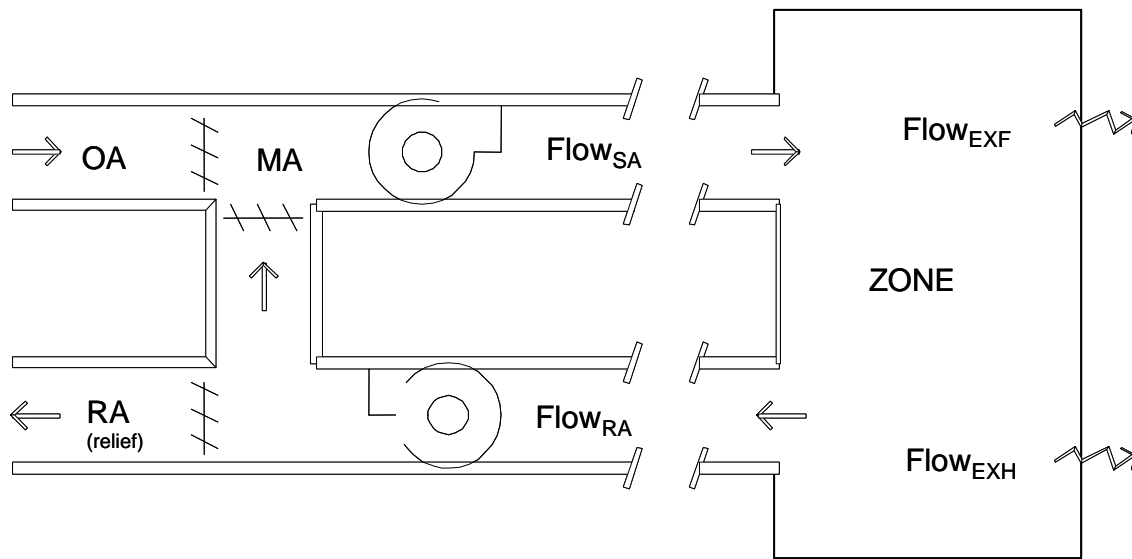


Figure 4-29. Air Flows in a Return Fan System.

4-4.6.4.4 Minimum OA (MINOA) quantity selection

The designer should coordinate the return fan Flow Difference Setpoint (**F-DIFF-SP**) with the minimum outside air flow selection.

The minimum outside air quantity (MINOA) used in conjunction with the **F-DIFF-SP** setting is determined by one of the following:

$$\text{MINOA} = \text{Flow}_{\text{vent}} \quad \text{if } \text{Flow}_{\text{vent}} > (\text{Flow}_{\text{exf}} + \text{Flow}_{\text{exh}}) \quad \text{Eq. 4-2}$$

$$\text{MINOA} = \text{Flow}_{\text{exf+exh}} \quad \text{if } \text{Flow}_{\text{vent}} < (\text{Flow}_{\text{exf}} + \text{Flow}_{\text{exh}}) \quad \text{Eq. 4-3}$$

Where:

$\text{Flow}_{\text{vent}}$ = Ventilation air flow (based on ASHRAE Standard 62, "*Ventilation for Acceptable Indoor Air Quality*").

Flow_{exh} = Zone exhaust flow, cfm or L/s (total of all exhaust fans in the zone)

Flow_{exf} = Zone exfiltration flow, cfm or L/s

(Note: If a CO₂-based demand controlled ventilation control strategy is to be used the F-DIFF-SP and MINOA flow selections must be coordinated.

The correct MINOA selection helps to ensure proper air distribution thru AHU by complementing the **F-DIFF-SP** value. The MINOA selection also applies to non-return fan systems.

Suggested designer selections, all to be shown in the Points Schedule, include the following: (1) Value of F-DIFF-SP, in L/s (cfm); (2) Value of return air duct airflow measurement array (AFMA) range, from 0 to a defined maximum value in L/s (cfm); (3) Value of supply air duct AFMA range, from 0 to a defined maximum value in L/s (cfm); and (4) Value of the minimum OA quantity in L/s (cfm).

4-4.7 Variable speed pump control

4-5.7.1 Variable speed pump control system design

A variable frequency drive (VFD) can provide significant energy savings realized from reduced pump horsepower as flow rate is decreased to match decreased load. Energy is saved at a cubed rate where even a small reduction in the pump's speed (such as 20%) can translate into a large energy savings (such as 50%). The greater the average annual load variation from maximum design conditions, the greater the energy savings potential with variable speed pumping. Variable frequency drives can also reduce maintenance (in the pump seals).

Figure 4-30 shows an example control schematic for a primary/secondary piping system where the secondary pump VFD is modulated by the direct digital controller (DDC) based on the piping system differential pressure in the downstream secondary piping loop.

Figure 4-30 shows that the piping system should have at least one 3-way valve or a bypass pipe. Locating the valve or bypass at or near the end of the piping run is not critical but helps to keep the chilled water loop cool and thus avoids a warm water surge at the chiller. A balancing valve in the 3-way valve bypass, set equal to the head loss across the coil circuit, can help with temperature control performance of the 3-way valve and can be used to provide adjustment of the minimum system flow. Adjustment of minimum system flow is not important in the secondary of a primary/secondary system but may be necessary where the variable speed pump loop consists of only a primary (no secondary) and the chiller (or boiler) has a minimum flow rating that must be observed. The chilled water pressure sensor (CWS-P) must be at or near the end of the piping run for sensing the differential between the supply and return mains.

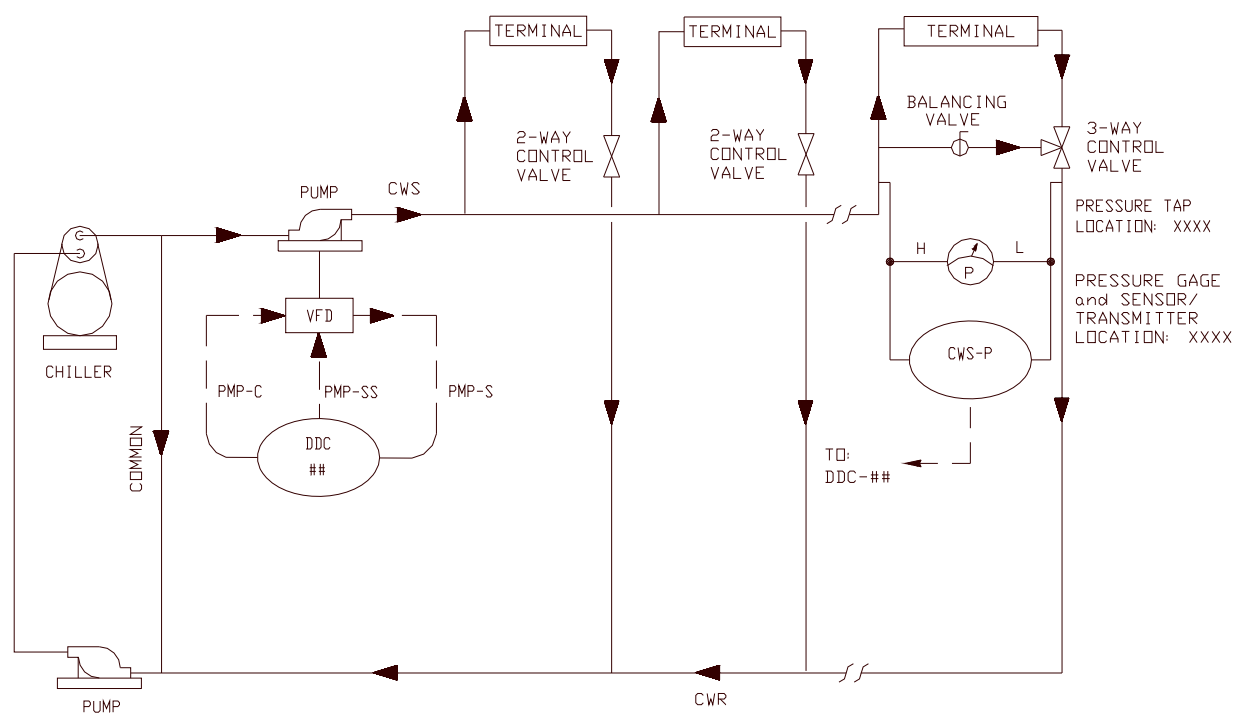


Figure 4-30. Primary/Secondary Pumping Control Schematic.

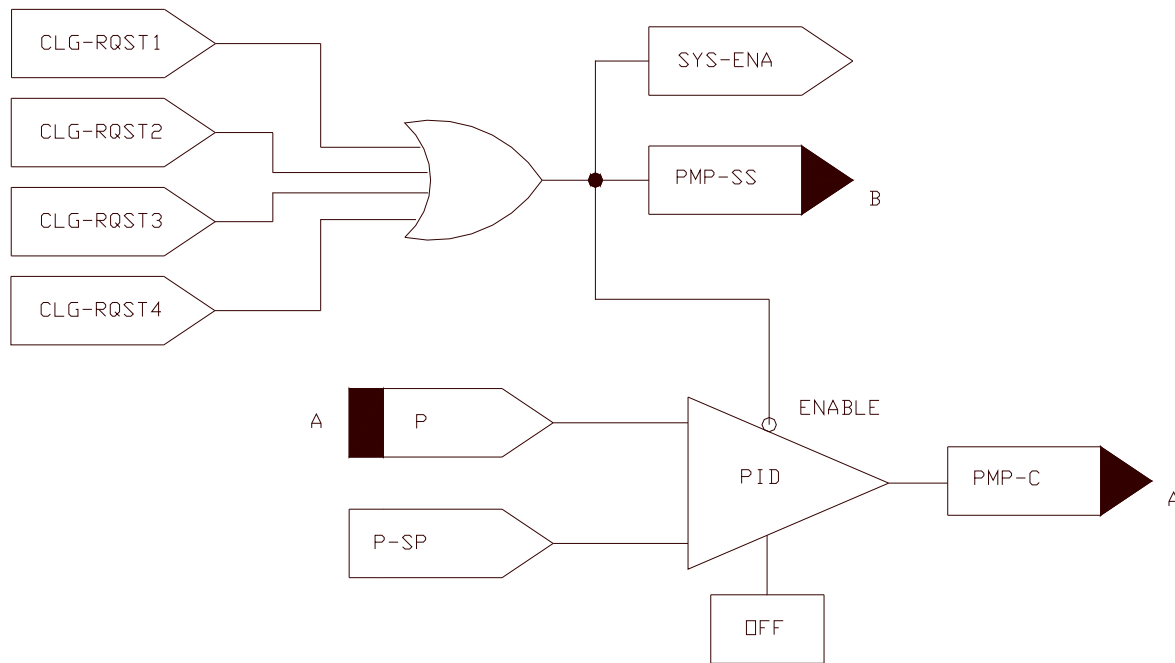


Figure 4-31. Variable Speed (Secondary) Pump CLD.

Figure 4-31 shows the CLD for this system. This system can monitor the enabled status (CLG-RQST) of all systems served by the variable speed pump system. If one or more of these systems are enabled, the VFD start/stop (SS) is 'started' and the variable speed PID control loop is enabled at minimum speed (typically 20%) and with a long ramp duration during initial start-up (typically 0.8 percent per second). The SYS-ENA signal is available to other systems as needed, such as activation of the chiller. The VFD pump command (PMP-C) signal modulates the VFD. As shown in Figure 4-32, when the VFD is placed in HAND mode it can be used to manually control the speed of the pump. A similar sequence is used in a heating application. When all enable requests stop, the DDC system ramps down the VFD to minimum speed, then shuts it off. While Figure 4-32 is shown with hardwired inputs/outputs, at the discretion of the installing Contractor, it may instead be provided with a TP/FT-10 network interface.

Once enabled, the variable speed pump increases or decreases speed in order to maintain a differential pressure between the supply and return water lines (typically at the worst case location in the facility) thus ensuring required pressure is available at all control valves in the system.

In some instances, a second pump is required to meet building demand. This is commonly referred to as a Lead/Lag system. In this scenario, the second (lag) pump is enabled whenever the first (lead) pump fails to provide "proof" that it is running (usually by means of a current sensing device) or if the first (lead) pump is operating at maximum capacity and the differential pressure set point is still not met. In this

UFC 3-410-02**19 Nov 2008**

condition, the second (lag) pump is energized and it runs in tandem at the same speed as the first (lead) pump in order to maintain differential pressure set point. Once both pumps decrease in speed below the tandem pump low speed set point the second (lag) pump will be turned off. The first (lead) pump will continue to run after the second (lag) pump has turned off. These pumps need to swap lead/lag designation periodically based on run time to ensure equal run time on each pump.

Variable speed control of hydronic systems can be difficult using PI or PID control because the speed of reaction of the system (i.e. the fluid) is very fast as compared to the ability of the DDC system to measure the change, transmit the new value to the controller, calculate a new output, and change the output to the VFD. The pressure transmitter hardwired directly to the pump controller will yield best performance.

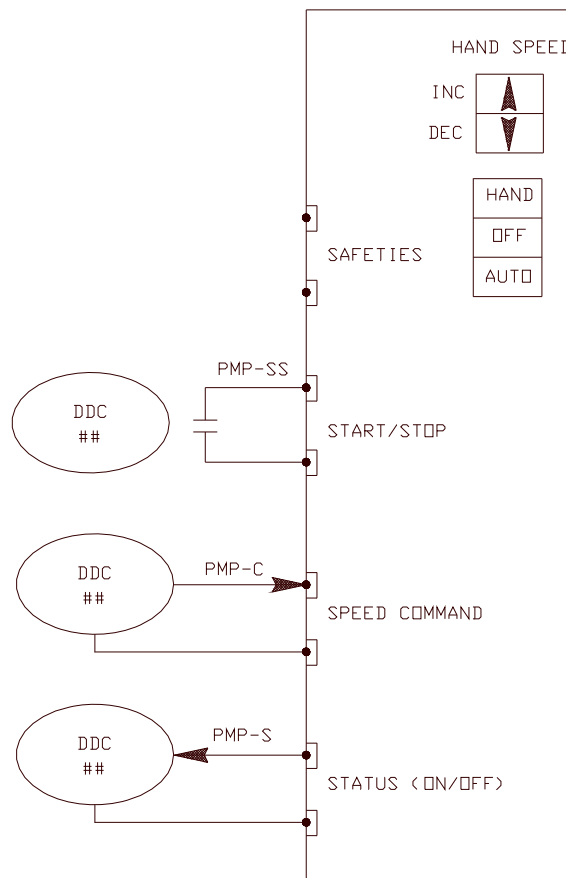


Figure 4-32. Variable Speed (Secondary) Pump Control - Ladder Diagram.

4-5.7.2 Designer selections

Designer selections for this loop include:

- (1) Differential pressure control setpoint (show in the Points Schedule). The designer must select the **initial** value based on piping system design. It should be equal to the value of the pressure drop across the terminal unit at or near the end of the piping loop. Note that the balancing Contractor must identify and set the **final** value of the control setpoint at design flow in coordination with the controls Contractor.
- (2) Differential pressure sensor/transducer range (show in the Points Schedule). The designer must select this value based on differential pressure control setpoint. The high end of the sensor range must exceed the control setpoint. Showing a high end range of no less than 150% is recommended. The guide specifications require that the Contractor not exceed this high end range by more than 50%.
- (3) Minimum VFD speed for safe pump/motor operation.

4-4.8 Humidity control loop

The humidity control loop, as shown in Figure 4-33, controls a humidifier to maintain the relative humidity setpoint. The loop consists of a space humidity controller and a high limit humidity controller. The valve opens to humidify when three conditions are met:

- (1) The fan is on; (2) The system is in occupied mode; and (3) The ventilation delay period has expired. Typical controller setpoints are 50% relative humidity (RH) for the space and 80% RH for the high limit.

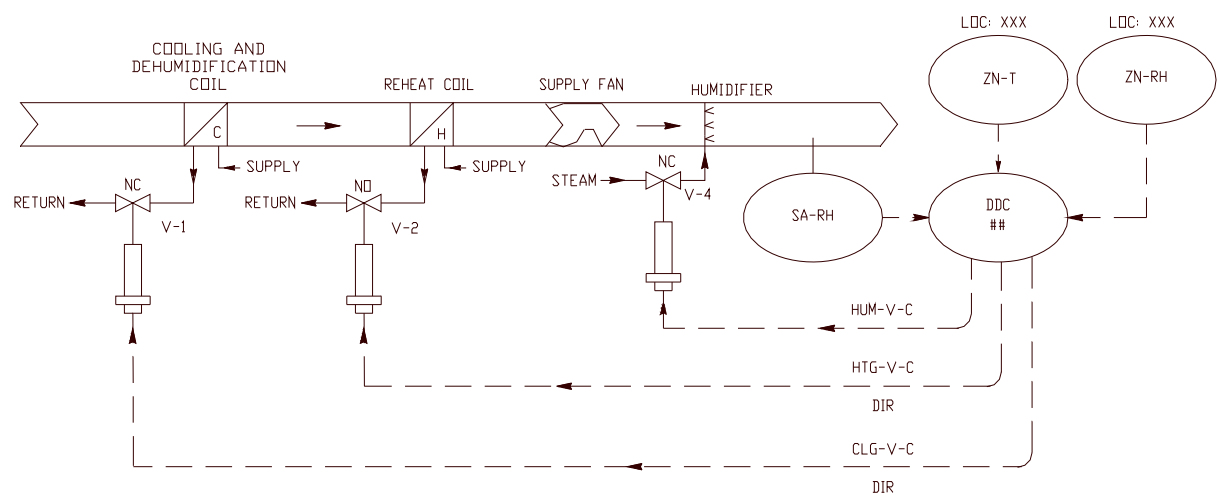


Figure 4-33. Humidity Control System Schematic.

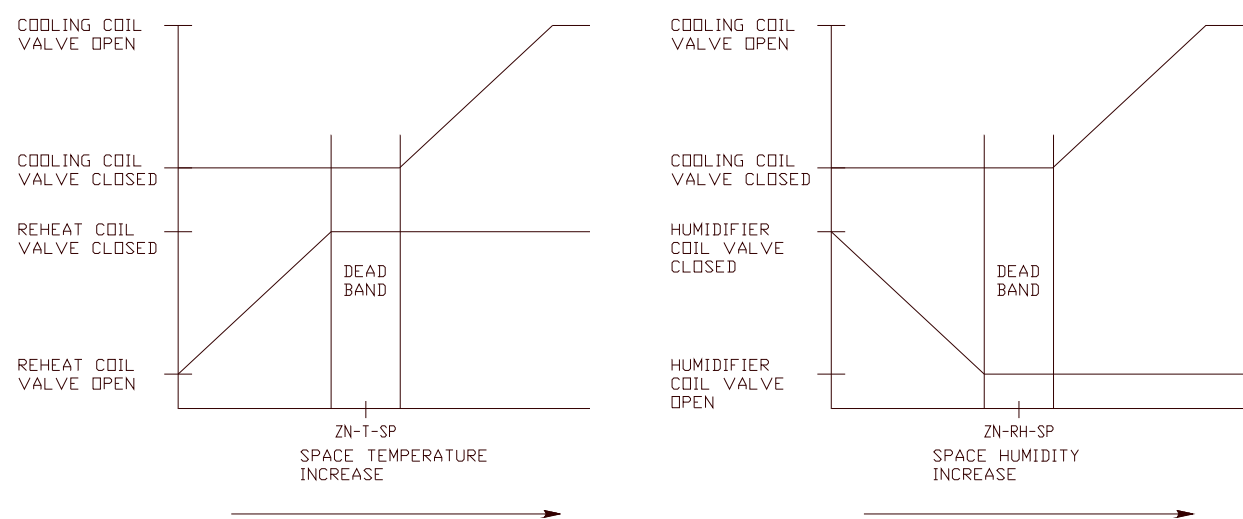


Figure 4-34. Humidity Control Sequencing Diagrams.

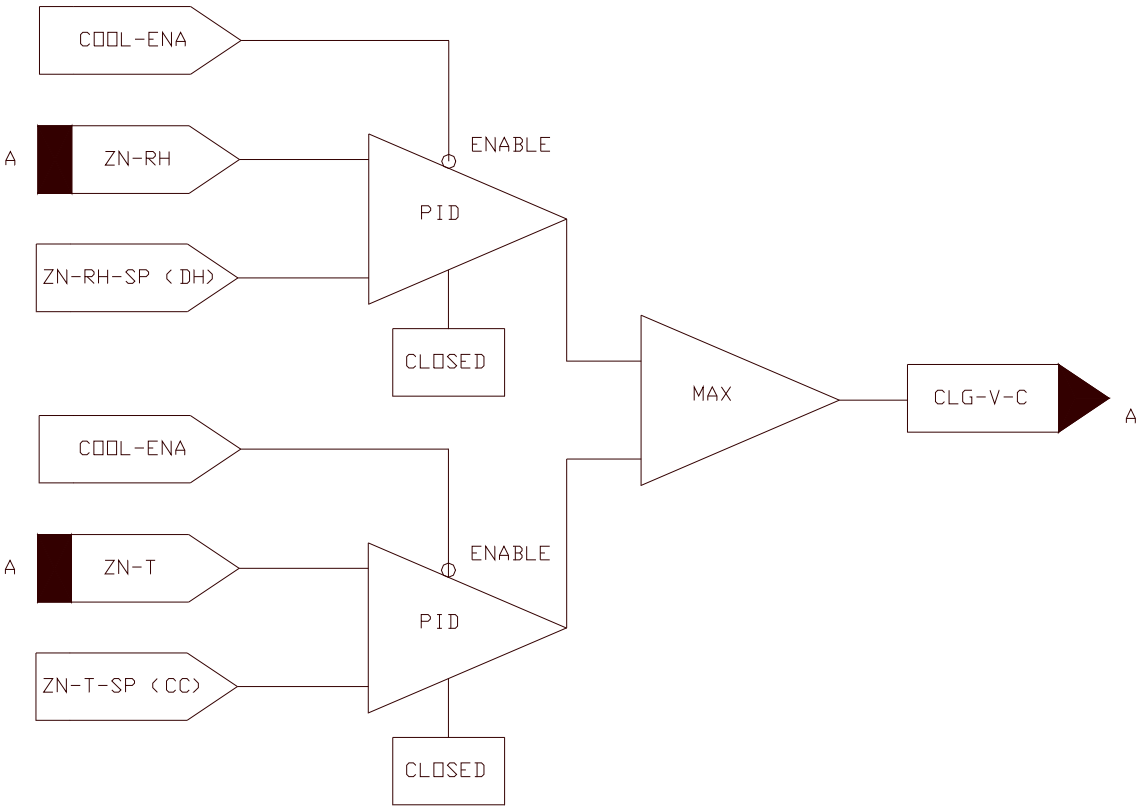


Figure 4-35. Cooling and Dehumidification CLD.

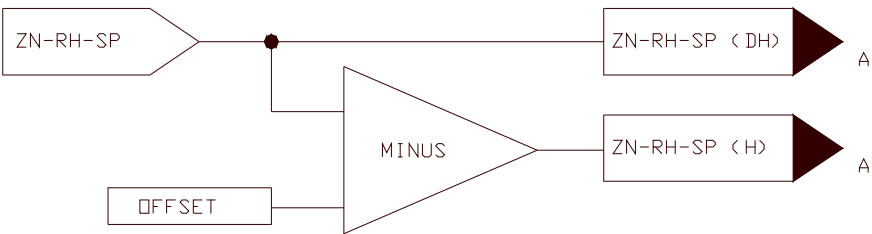


Figure 4-36. Dehumidification / Humidification Sequencing CLD.

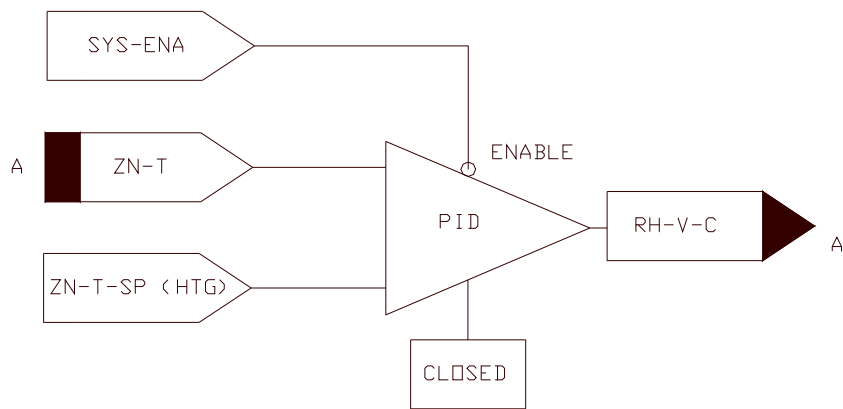


Figure 4-37. Reheat Coil CLD.

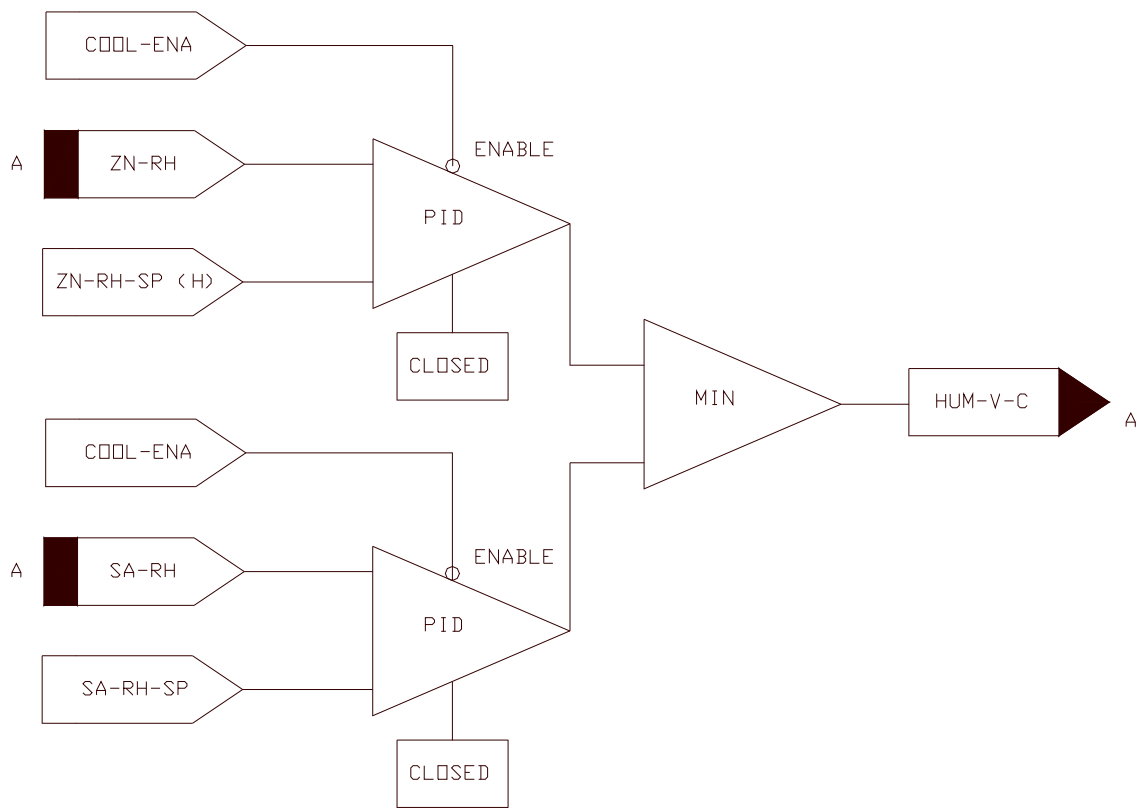


Figure 4-38. Humidifier CLD.

4-4.9 Alarms

4-4.9.1 UMCS Alarms

DDC system points (via their associated SNVTs) can be monitored by a UMCS which, in turn, determines when a point is in an alarm condition. The UMCS performs alarm generation, notification, and routing functions. The DDC system designer must specify the alarm points by showing them in the Points Schedule where the DDC Contractor is then responsible for providing a SNVT for each point that has an alarm condition assigned to it.

4-4.9.2 System Scheduler

Although LonMark International has developed “scheduler” and “calendar” Functional Profiles, there is not an industry-standard way to perform scheduling in an Open manner. For this reason, DDC UFGS 23 09 23 includes detailed requirements for a System Scheduler to perform scheduling.

There are four things that can affect the occupancy status of a piece of equipment. In order from lowest to highest priority:

- Scheduled Occupancy
- Occupancy Sensors (turn on only)
- Occupancy overrides from M&C (demand limiting, operator overrides, etc.)
- Night Stat (turn on only)

The System Scheduler has inputs from the M&C software as well as from local occupancy sensors and turns equipment on or off depending on these inputs.

4-4.9.3 System scheduler inputs

DDC UFGS 23 09 23 standardizes the input to the system scheduler as a SNVT of type SNVT_Occupancy. Therefore, all system schedulers, regardless of who installed them, communicate with the UMCS in a standard fashion. The guide specification doesn't require a specific SNVT type between the system scheduler and the equipment it schedules but this communication must be documented by the Contractor on the Points Schedule.

Depending on the Air Handler, the Occupancy Sensor input may or may not be directly from an occupancy sensor. For air handlers with terminal units (i.e. VAV boxes), the occupancy sensor is used to turn the terminal unit (VAV box) on and the occupancy mode of the terminal unit is used by the system scheduler to determine what the air handler should be doing. If the air handler doesn't have terminal units it will use inputs directly from the occupancy sensors.

4-4.9.4 Warm-Up Cool-Down mode

The only difference between Warm-Up Cool-Down (WUCD) and occupied (OCC) mode is that in WUCD mode the outside air loop is disabled so the air handler does not

UFC 3-410-02**19 Nov 2008**

condition outside air. Since Terminal Units don't condition outside air, they can just run in OCC mode when the air handler is in WUCD.

4-4.9.5 Default schedule

The System Scheduler contains a backup (default) schedule that becomes active in the event that the UMCS Monitoring and Control software is not present (either because the UMCS is 'down' or because it doesn't exist). If the System Scheduler hasn't received a scheduled occupancy input for more than 95 minutes it will use the default schedule. Note that occupancy sensors (if specified to do so) can still place the system (hardware) in the occupied mode.

CHAPTER 5

CONTROL SYSTEM DRAWINGS

5-1 CONTROL SYSTEM DRAWINGS OVERVIEW

This chapter describes typical control system drawings and how to edit them to be project-specific. CHAPTER 6 PROJECT IMPLEMENTATION provides an overview of the project-specific drawing requirements detailed in this chapter. Example drawings are available from:

<https://eko.usace.army.mil/fa/bas/>

The drawings were originally developed using AutoCAD® and every effort was made to ensure compliance with A/E/C CADD Standard Release 2.0.

5-2 CONTRACT DRAWING SET

A set of Contract drawings will ordinarily consist of:

- Index (title sheet)
- Symbols and Legend drawing
- Points Schedule - Contactor Instructions
- System Scheduling Sequence
- Alarm Generator and Alarm Handling Sequence
- System specific drawing set

A system specific drawing set consists of (as applicable):

- Control Schematic
- Ladder Diagram
- Control Logic Diagram
- Sequence of Operation
- Points Schedule
- Other Schedules:
 - Thermostat and Occupancy Sensor Schedule
 - Occupancy Schedule
 - Redundant Alarm Handling Schedule
 - Control Damper Schedule
 - Control Valve Schedule

As part of the editing process to make the sample drawings project-specific, the sample drawings use the following conventions:

- Entries required of the designer are shown bracketed as: [____]

- Entries required of the Contractor are shown bracketed as: < ____ >
- Spaces where no entry is ordinarily required contains a tilde: " ~ " (equivalent to an "n/a" or null value)

The bracketed [____] designer entries in the sample drawings are shown/provided as a guide to the designer. These entries must be verified or changed by the designer. When editing the drawings, delete the brackets after verifying/providing the entry. Contract drawings should contain no designer brackets [____]. Do not leave cells blank. Instead show the tilde ("~") to indicate a null value or that no further entry is required.

5-3 SYMBOLS AND UNIQUE IDENTIFIERS

The control drawing symbols and identifiers adhere to a convention that is intended to uniquely identify each control system device and signal and to make interpretation of the control drawings as simple and as self-evident as possible. This includes the use of a defined set of symbols along with a naming convention for these symbols and their associated input and output signals.

5-3.1.1 Symbols

Control schematic symbols: The generic symbol for a device used in a control schematic drawing is an oval bubble as shown in Figure 5-1. Devices can be shown with multiple input or output signals or additional I/O detail as shown in illustrations (B) and (C). The identifying letters and numbers associated with the symbols and signals are described in paragraph 5-3.1.2. Although not shown in Figure 5-1, most instrumentation symbol bubbles will show additional instrumentation detail such as a connected temperature probe or airflow measurement array.

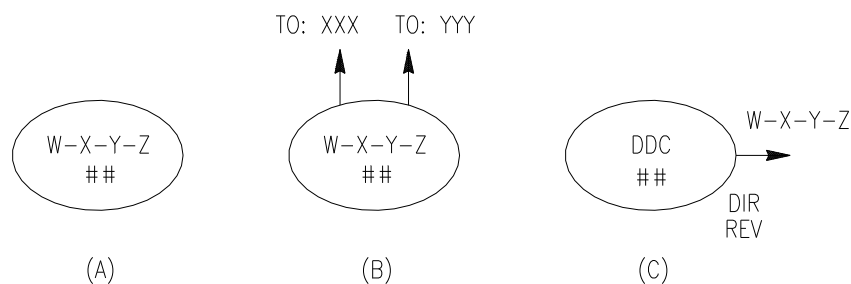


Figure 5-1. Generic Device Symbols.

Control logic diagram symbols: There are a variety of symbols used to construct control logic diagrams. They have identifying letters and numbers associated with the symbols and input/output signals as described in paragraph 5-3.1.2.

5-3.1.2 Unique identifiers

Device symbols and their associated input/output signals use a naming convention consisting of abbreviations and acronyms (W-X-Y-Z and ##), as shown in Figure 5-1, that describe the device or signal. Note that a signal can be a hardwired input or output to or from a device as shown in a control schematic or can be a logical constant or variable as shown in a control logic diagram:

- **W** - Device descriptor; Describes the device, physical location of the device, source of the signal, destination of the signal, or the apparatus/function being controlled. In some cases, a two-part device descriptor is used. For example, MA-FLT is used to describe the mixed air filter.
- **X** - Measured variable or controlled device; In the case of a sensor or measurement instrument, it is temperature (T), relative humidity (RH), pressure (P), etc. In the case of an output, it can describe the actuated device such as a valve (V) or damper (D).
- **Y** - Modifier; In some cases, a modifier is required, such as indicating that a signal is a low-limit (LL) or high-limit (HL) input. Alternatively, the modifier may be used to describe the type of control signal such as a modulating command (C), start/stop (SS), enable (ENA), or disable (DIS) signal.
- **Z** - In some cases, an additional modifier is required, such as indicating that a signal is a setpoint (SP).
- **##** - Device or signal number; When there are multiple identical control devices or signals, sequential numbering is used to avoid duplicate unique identifiers. All DDC controllers are numbered (by the Contractor), even if there is only one. The intent is to be able to show a single (common) DDC controller multiple times on a drawing. This can help simplify the control drawings by showing fewer signal lines connected to several DDC controllers instead of showing numerous signal lines connect to a single DDC controller. It also provides leeway to the Contractor to use multiple controllers where project application requirements dictate the need.

Some example device symbol and signal names include:

- MA-T: Mixed air temperature
- MA-D-C: Mixed air damper command
- MA-T-LL: Mixed air temperature low limit
- ECO-ENA: Economizer enable
- ECO-HL-SP: Economizer high-limit setpoint
- ECO-LL-SP: Economizer low-limit setpoint
- SA-T: Supply air temperature
- SA-T-SP: Supply air temperature setpoint
- CLG-V-C: Cooling coil valve command
- SF-C: Supply fan command (modulating control signal)
- SF-SS: Supply fan start/stop
- SF-S: Supply fan status

5-4 POINTS SCHEDULE

5-4.1 Overview

The Points Schedule drawing conveys a great deal of information critical to the design, installation, and subsequent performance of the control system. It includes hardware input/output information, device ranges and settings, and CEA-709.1 communications protocol data. It also includes information about data that is to be accessible at the operator workstation by the UMCS UFGS 25 10 10 Monitoring and Control software.

The Points Schedule Instructions drawing describes Contractor requirements for control system implementation including how to use, complete, and submit the Points Schedule drawing.

5-4.2 Responsibilities

The designer is responsible for the initial set of Points Schedule entries. The UFGS 23 09 23 Contractor is responsible for the bulk of the entries and submits the Points Schedule as a Design Drawing for government approval and then finalizes it as an as-built submittal. The as-built is then used as a contract drawing by the UMCS Contractor. Contractor responsibilities are described in the specifications and in the Points Schedule drawing notes.

5-4.3 UMCS content shown on UFGS 25 10 10 points schedules

Some columns in the Points Schedule (labeled "M&C") pertain to functionality provided by the Monitoring and Control (M&C) Software specified in UFGS 25 10 10. These columns include SNVT names that the building DDC system (UFGS 23 09 23) must provide for present or future use by the UMCS. Then, as stated in the Points Schedule Instructions drawing, when the building control system is integrated into a UMCS, these columns tell the UMCS Contractor what functionality to configure in the M&C Software. If the building will be 'stand-alone' and M&C functionality is required at the building level (to be provided by the DDC UFGS 23 09 23 Contractor), certain requirements from UMCS UFGS 25 10 10 must be added to the DDC UFGS 23 09 23 specification or an edited version of UMCS UFGS 25 10 10 must be used in conjunction with the DDC UFGS 23 09 23 specification. *Note that in the absence of adequate documentation on the Points Schedule by the DDC Contractor, the UMCS Contractor will be unable to integrate the building into the UMCS.*

5-4.4 Points schedule description and instructions

Points Schedule columns and entries are described below along with any designer responsibilities. The responsibilities of the installing Contractor are described on the Points Schedule Instructions drawing.

5-4.4.1 Header information

5-4.4.1.1 DDC hardware identifier

A unique identifier is used to identify the control hardware device on the Points Schedule, Control System Schematic, and other drawings and helps to maintain consistency between drawings. Note that this DDC Hardware identifier is different than the NodeID and the Node field of the address which are described below. The UFGS 23 09 23 Contractor is required to provide this information.

5-4.4.1.2 DDC hardware location

The physical location of the DDC Hardware. The UFGS 23 09 23 Contractor is required to provide this information. Minimally this includes the room number where the DDC Hardware is located.

5-4.4.1.3 Node address

The logical address of the node (DDC Hardware) on the network which consists of three fields: domain, subnet, and node. The UFGS 23 09 23 Contractor is required to record the entire device address on the Points Schedule

5-4.4.1.4 Node ID

A unique 48-bit identifier assigned (at the factory) to each CEA-709.1 device (often called the Neuron ID). The UFGS 23 09 23 Contractor is required to provide this information.

5-4.4.2 General columns: description and instructions

5-4.4.2.1 Function

Basic description of the function performed by this group of points.

5-4.4.2.2 Name

This is the point name. The UFGS 23 09 23 Contractor will provide point names as needed (for those points not already named) using the points abbreviations. The UMCS UFGS 25 10 10 Contractor will use these point names on graphic displays.

5-4.4.2.3 Description

This is a summary description of the point.

5-4.4.2.4 Setting

UFC 3-410-02**19 Nov 2008**

This shows setpoints, configured setpoints, configuration parameters, and settings related to each point. (These are values established in the controller by the UFGS 23 09 23 Contractor, either by dip switches, hardware settings, controller programming software, or LNS plug-in.) The designer should show setpoints and settings as required. Typical values are shown in the typical drawings. Include the appropriate engineering units for entries in this column.

The UFGS 23 09 23 Contractor will use these settings when configuring devices and will show the setting used where the design did not show or specify one.

5-4.4.2.5 Range

Shows the range of values associated with the point. For example, it could be a zone temperature setpoint adjustment range, a sensor measurement range, occupancy values for an occupancy input, or the status of a safety. The designer should edit this column as required, including the appropriate engineering units. In general, the following will need to be edited:

- Zone setpoints
- Switch settings
- Occupancy modes – Must be consistent with the sequence of operation or use “<_>” to indicate that the DDC UFGS 23 09 23 Contractor is to provide this information.

The UFGS 23 09 23 Contractor will use these ranges when configuring devices, and will document the ranges used for those that aren't shown. Note that the UFGS 23 09 23 Contractor must select ranges to meet UFGS 23 09 23 (e.g. permissible range of a temperature sensor).

5-4.4.2.6 nci/CP name

The name of the network configuration input (nci) or configuration parameter (CP) for this setting as specified in UFGS 23 09 23. The UFGS 23 09 23 Contractor provides this information for programmable controllers or application specific controllers that don't have LNS plug-ins.

5-4.4.2.7 I/O type

Shows the input/output signal type (if any) associated with the point. Point types can be either hardware I/O or network variable points:

- Hardware I/O
 - Analog Input (AI)
 - Analog Output (AO)
 - Binary Input (BI)
 - Binary Output (BO))
- Network variable points:
 - Network Variable Input (NVI)

- Network Variable Output (NVO)

The UFGS 23 09 23 Contractor will document the I/O used in this column, including any network inputs and outputs used to share information between DDC Hardware.

5-4.4.3 LDP and M&C display columns

5-4.4.3.1 LDP view req'd

An “X” entry in this column indicates that the point is to be viewable from a Local Display Panel (LDP).

5-4.4.3.2 M&C disp req'd

An “X” entry in this column indicates that the point is to be displayed on a workstation via Monitoring and Control (M&C) software.

5-4.4.3.3 M&C trend req'd

An “X” entry in this column indicates that the point is to be trended by the Monitoring and Control (M&C) software.

The intent of showing that a point is to be trended is to require the UMCS UFGS 25 10 10 (UMCS) Contractor to set up a trend for the indicated points. Note that points not marked with an “X” may still be trended at a future time.

5-4.4.3.4 SNVT type

The UFGS 23 09 23 Contractor will show the SNVT type for all network variables

5-4.4.4 Overrides columns

5-4.4.4.1 LDP ovrd req'd

An “X” entry in this column indicates that the point can be overridden (adjusted) from a Local Display Panel (LDP). If this column contains an “X”, the **LDP VIEW REQ'D** column for that point should also contain an “X”.

5-4.4.4.2 M&C ovrd req'd

An “X” entry in this column indicates that the point can be overridden (adjusted) from an operator workstation. The designer should place an X in this column for each point that requires override capability from the M&C Software. Note that, in general, overrides should not be needed nor specified for inputs (process variables) and should be limited to setpoints and outputs.

5-4.4.5 Alarms columns

Alarms are handled by the UMCS (as specified by UMCS UFGS 25 10 10) where the M&C software monitors the specified points (via their associated SNVTs) and performs alarm generation, notification, and routing functions. Refer to 5-4.4.5.3 for a description of UMCS alarm handling

5-4.4.5.1 Alarm condition

This column shows the condition(s) for each point at which an alarm occurs. Some alarms include time delays where the intent is to prevent nuisance alarms on equipment start up. Time delay duration is shown in the sample drawing "NOTES". The designer should show the alarm condition(s) for each point.

5-4.4.5.2 Alarm priority

This column shows the UMCS-assigned priority for alarms as either Critical (CRIT) or Informational (INFO). As specified in UMCS UFGS 25 10 10, critical alarms remain in alarm until acknowledged by a UMCS operator and the alarm condition no longer exists. Informational alarms remain in alarm until the alarm condition no longer exists or until the alarm is acknowledged. The designer should show the alarm priority for each alarm.

5-4.4.5.3 M&C routing

This column shows the name of the alarm routing group that is to be used for each alarm to be handled by the UMCS. The routing group specifies the destinations for each alarm message and, as specified in UMCS UFGS 25 10 10, each group consists of some combination of a pop-up message on one or more workstations, an email to one or more individuals, paging of one or more individuals, or printing to one or more printers.

- If there is an existing UMCS or if this system is to be interfaced with a UMCS, coordinate with the installation and show the M&C Routing group name for each alarm.
- If there is not an existing UMCS, leave the entries in this column in brackets [____] indicating it is a future design option to be completed when the UMCS is designed.

M&C Routing is described in more detail in UMCS UFC 3-401-01.

5-4.5 Points schedule application notes

These notes describe Points Schedule entries for specific rows shown in the Schedule.

5-4.5.1 Analog and binary inputs

Any analog input (AI) or binary input (BI) can be viewed from an LDP or displayed using M&C software at a workstation but AI's and BI's should not be overridden from an LDP or workstation (in addition, many application specific controllers do not support this functionality). In the event an AI or BI must be overridden, such as during start-up testing, it can be overridden using a network configuration tool.

5-4.5.2 System reset button (RST-BUT)

The activation of any safety will result in system shutdown. The system remains shutdown until devices requiring manual reset (such as a low limit switch with a reset button) are reset and the system reset button (RST-BUT) signal is activated. This could be either a binary input (BI) (pushbutton) local to the DDC controller or a network variable input (NVI) SNVT from a workstation or local display panel (LDP).

It is recommended that the designer coordinate the decision on how to perform system reset with the local O&M staff. If System Reset is to be performed from a local push button, show "BI" under the I/O TYPE column and show a tilde in all other columns. If System Reset is to be performed via a network variable from the M&C Software and/or an LDP, show an "X" in the M&C OVRD REQ'D column and/or the LDP OVRD REQ'D column. The possible combinations for the RST-BUT are summarized in Table 5-1

Table 5-1: System Reset Button Options and Points Schedule Entries

System Reset From	Entry in I/O column	Entry in M&C OVRD REQ'D Column	Entry in LDP OVRD REQ'D Column
Local Push-Button Only	BI	~	~
Local Push-Button or M&C Software	BI	X	~
Local Push-Button or LDP	BI	~	X
Local Push-Button, LDP or M&C Software	BI	X	X
M&C Software Only	~	X	~
LDP Only	~	~	X
LDP or M&C Software Only	~	X	X

In addition to showing the RST-BUT functionality in the Points Schedule, edit the Control Logic Diagram as required.

5-4.5.3 System occupancy (SYS-OCC)

Most systems will obtain their occupancy mode command (OCC, UNOCC, Warm-up/Cool-down) from a System Scheduler. The occupancy mode for the system is overridden via an override input to the System Scheduler, not to the DDC Hardware performing the specific system sequence of operations, so the system should never have an 'X' in either the M&C or LDP Override columns. Systems that do not require

scheduling will not have a SYS-OCC row shown on the Points Schedule. For example, many infrared heating systems operate according to a manual on/off or an occupancy sensor.

Show SYS-OCC (include this row) for any system that is to operate according to a schedule. Show Occupied, Unoccupied and WUCD (Warm-up/Cool-down) scheduling times (hours of operation) in the OCCUPANCY SCHEDULE Drawing.

5-4.5.4 Zone occupancy (ZN-OCC) and effective occupancy (EFF-OCC)

The operational mode (occupied or unoccupied) of a piece of DDC Hardware used to provide environmental control of a space or zone can be dictated by either the System Scheduler (SYS-OCC) or by a binary input (BI) occupancy signal from the zone (ZN-OCC). This BI occupancy signal (ZN-OCC) can be from either an occupancy sensor or from an occupant accessible push button.

For systems such as VAV boxes that require a servicing AHU, the EFF-OCC signal is a network variable output (NVO) from the DDC Hardware (controller) which indicates the current operational mode for the system. This output is used for monitoring the system and (for terminal units requiring air handler service) as an input to the System Scheduler to allow the System Scheduler to place the serving AHU into occupied mode.

If the design is to include either an occupancy sensor or occupancy push button, include both the ZN-OCC and EFF-OCC rows in the Points Schedule. On the Occupancy Sensor Schedule, show the quantity of ZN-OCC BI's (i.e. the number of occupied zones) required to cause the System Scheduler to turn on the AHU that serves these zones. A minimum of two BI's are recommended to help minimize inadvertent starting of the AHU due to cleaning or security staff passing through after hours.

5-4.5.5 LDP view and override

The designer may require that LDPs be installed in each mechanical room where the intent is to support air handlers and other primary equipment such as hydronic systems. On the other hand, the template Points Schedules for Terminal Units shows no LDP 'view' or 'override' capability in large part because these units include thermostats that ordinarily provide an adequate operator interface. The designer may choose to show LDP functionality.

5-4.5.6 Minimum outside air flow

The minimum outside air flow is the quantity of outside air required for fresh air or for makeup. Show the minimum outside air flow setpoint (MINOA-F-SP) when the outside air flow quantity is controlled using DDC Hardware, an air flow measurement array, and a flow control damper. Otherwise (where there is no closed loop control, such as in a constant volume system), show the minimum OA flow quantity as "Minimum Outside Air Flow Setting". In that case, it does not have a point NAME because it is not an actual signal (not measured using an installed sensor).

5-4.5.7 PID loop settings

The PID Loop Settings are all the settings required to configure PID control, including but not limited to the P, I, and D gains, deadbands, and reset schedules.

5-4.5.8 Filters

As described in the Sequence of Operation Designer Notes, delete the filter pressure high limit switches if/where they are not needed. When filter switches are used, show on the Points Schedule whether the filter status should be displayed at an LDP or UMCS, or if the filter should be routed as an Alarm.

5-4.5.9 Other points

These are points which are not associated with a control loop and are therefore included for monitoring purposes only.

5-4.5.10 Unit status

The Unit Status point indicates if the system is operating in heating/cooling mode. This status is used as a monitored point at the M&C Software and as a heating/cooling request to a chiller, boiler, or heat exchanger. For systems other than heat exchangers, a network variable of type SNVT_HVAC_STATUS is used for this point and the range shown for this point applies to the MODE Field of the SNVT. For heat exchangers, a network variable of type SNVT_SWITCH is used instead.

5-4.5.11 Heating request and cooling request

DDC Hardware controlling chillers, boilers and heat exchangers receive Unit Status inputs from their serviced equipment in the form of heating/cooling requests. The DDC hardware will use these Unit Status inputs to determine whether to start/stop their controlled equipment (e.g. the DDC hardware controlling the chiller may require that three AHUs are calling for cooling prior to starting the chiller). The Chiller, Boiler, or Heat Exchanger System Enable schedule shows under what conditions the equipment will be enabled.

5-5 CONTROL SYSTEM SCHEMATIC

The control system schematic provides a functional representation of the control system. It shows control loops, control system devices, their symbols, unique identifiers, and associated input and output signals. It also contains space for designer notes. Depending upon the particular system, the control system schematic might also show Sequencing Diagrams. It is used to complement the sequence of operation, along with the other control system drawings, and must be coordinated with the sequence of operation and the devices and signals shown in the other drawings.

5-5.1 Loops and devices

Each control system schematic consists of one or more loops with associated control hardware and devices including DDC hardware, input devices (sensors and other instrumentation), output devices (valves/dampers/fans/pumps), and multi-function devices. With few exceptions, such as valves, dampers, fans, and pumps, all control devices and signals shown in the Control Schematic should also be shown in the Points Schedule. Valve and damper details are shown in their respective schedules.

The control system schematic must be edited to be project specific and consistent with the other Contract drawings:

- Edit the border as required.
- Provide/show an identifier for the 'system'.
- Add or delete loops and devices as required.
- Show other points (sensors) that will be used for monitoring purposes only and show these Other Points in the Points Schedule.
- Show pneumatic actuation if desired, including positive positioners. By default, valve and damper actuators will use electric actuation.
- Where applicable, show the locations of permanent instrumentation in coordination with other drawings (M-plates).

5-5.2 Sequencing diagrams

A Sequencing Diagram shows the heating, deadband, and cooling temperature ranges for controlled devices and equipment. Default Sequencing Diagrams are shown on the typical control drawings and must be edited to be project specific. Show device sequencing for primary equipment such as single-zone air handlers, multizone zone temperature controls and terminal unit equipment, such as VAV boxes and fan coil units on the Control Schematic. In most cases, the sequencing is dependent upon the mode of operation such as occupied, unoccupied, and warm-up/cool-down. Sequencing is further described in the respective written Sequence of Operation and, when used, the Control Logic Diagram.

5-5.3 Designer notes

The Control System Schematic has space provided for designer notes including pre-defined/default notes.

5-6 LADDER DIAGRAM

The ladder diagram, sometimes referred to as a fan or pump starter circuit or wiring diagram, shows control system equipment interlocks and interfaces. In most cases, these interlocks will be with fan and pump motor starters or variable frequency drive units. In the case of HVAC system equipment, the interlocks will usually include hand-off-auto switches, freeze stats, smoke detectors, fire alarm panel interface, and the

emergency shutdown switch. Default Ladder Diagrams are shown on the typical control drawings and should be edited to be project specific.

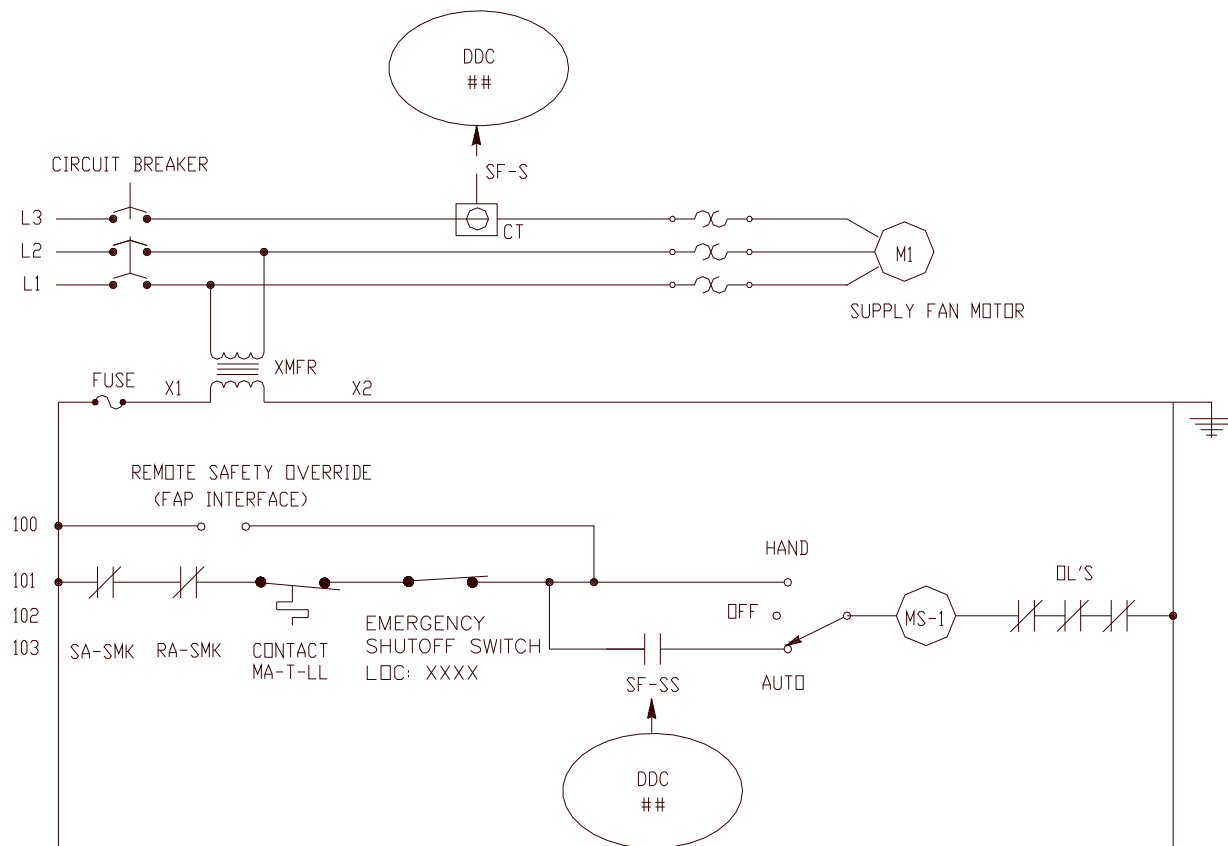


Figure 5-2. Sample Ladder Diagram.

5-7 CONTROL LOGIC DIAGRAM

The control logic diagram (CLD) drawing is intended to be an unambiguous graphical description of the control system sequence of operation. It provides detail that may not be evident in the written sequence. The focus of the CLD is on control logic, not on a particular hardware implementation. Inclusion of a CLD in the Contract drawing package is optional depending on the desired degree of specificity in the design. Use of a CLD is recommended where precise implementation of a particular control sequence is needed. It is also beneficial as part of project quality verification as it can be used as a tool to verify proper implementation of the control sequence.

The CLD must be edited to be project specific and consistent with the other Contract drawings. A control logic diagram tutorial is contained in the Appendix.

5-8 SEQUENCE OF OPERATION

The sequence of operation drawing shows a written description of the control logic. The written sequences are part of DDC UFGS 23 09 23. To avoid confusion, these sequences were not repeated on the typical control drawings. The sequence must be edited to be project specific and consistent with the other Contract drawings and be copied onto the Sequence of Operation drawing.

5-9 THERMOSTAT AND OCCUPANCY SENSOR SCHEDULE

The Thermostat and Occupancy Sensor Schedule (Figure 5-3) shows requirements for space mounted devices.

SYSTEM SERVICE (AHU)	TERMINAL UNIT IDENTIFIER	SPACES SERVED	STAT LOCATION	ZN-T	ZN-T-SP ADJUST	UNOCC OVERRIDE PUSHBUTTON	UNOCC OVERRIDE TIME	OCC SENSOR
[____]		RM-[____] RM-[____]	RM-[____]	[_]	[_]	[_]	[____]	[_]
[____]		RM-[____] RM-[____] RM-[____]	RM-[____]	[_]	[_]	[_]	[____]	[_]
[____]		RM-[____]	RM-[____]	[_]	[_]	[_]	[____]	[_]

Figure 5-3. Thermostat and Occupancy Sensor Schedule.

5-9.1 Thermostats

Note that the definition of a thermostat (STAT) is used somewhat loosely here in that (contrary to the historical definition, but in line with current usage) the thermostat does not necessarily provide a control output (to modulate or position an end device). Instead, the thermostat will contain a temperature sensor and one or more of an occupant adjustable setpoint input, an occupancy sensor, or an unoccupied mode override (manual pushbutton). The intent and application of a thermostat, along with the technical requirements, are clear in the drawings and specifications (including 'User Input Devices' and 'Multifunction Devices').

5-9.2 Occupancy sensors

Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Occupancy sensor location, within the room/space, is left up to the Contractor. If ceiling mount sensors are preferred, edit the sequences and/or indicate in the Thermostat and Occupancy Sensor Schedule.

5-9.3 Schedule entries

Show project specific entries in the Thermostat and Occupancy Sensor Schedule columns:

- **System Service:** Show an identifier for the system, such as the air handler, that services/supplies the space. Ensure coordination/consistency with other mechanical system drawings.
- **Terminal Unit Identifier:** Show an identifier when applicable, such as in a VAV system. Ensure coordination/consistency with other mechanical system drawings.
- **Spaces Served:** Show the room or rooms serviced by the thermostat and/or occupancy sensor. In general, all stats and occupancy sensors for a given terminal unit should be shown on the same line. However, there may be cases where additional rows may be required. For example, if a VAV zone consists of multiple spaces, a single thermostat but multiple occupancy sensors (one in each space/room) may be desired. The designer might choose to show a separate row for each occupancy sensor. Alternatively, a comment could be added to the column entitled 'Other' to clarify the requirement for a single thermostat with multiple space occupancy sensors.
- **STAT Location:** Show the physical location of the thermostat.
- **ZN-T:** Thermostats should always include a temperature sensor, so there should always be an 'X' in this column.
- **ZN-T-SP Adjust:** Show an 'X' if the thermostat is to include an occupant adjustable setpoint (thumb wheel or sliding bar). Where a non-(occupant)-adjustable setpoint is specified, show the (configured) setpoint in the Points Schedule. When using non-adjustable setpoints, be sure to indicate on the Points Schedule that the setpoint must be capable of being overridden from the M&C Software or an LDP.
- **OCC Pushbutton:** Show an 'X' if the thermostat is to include an occupant accessible pushbutton to override the unoccupied mode and start the servicing system for a duration shown under the UNOCC Override Time.
- **OCC Pushbutton Time:** If an 'X' is shown in the UNOCC Override Pushbutton column, show the time duration that the system will remain in Occupied mode after pressing the UNOCC Override Pushbutton.
- **OCC Sensor:** Show an 'X' if the space is to include an occupancy sensor. The occupancy sensor specification requires a 15 minute off-mode delay prior to leaving the occupied mode. If a different time is desired, show it in the thermostat

schedule and ensure that it is consistent with the DDC UFGS 23 09 23 occupancy sensor product specification.

5-10 OCCUPANCY SCHEDULE

The Occupancy Schedule shows the system modes (Occupied, Unoccupied, and Warm-Up/Cool-Down) and when the system should be in each mode. Two sets of times are shown. One for the normal operating schedule set at the UMCS and one for the default schedule in the building which is active if connection to the UMCS is lost. In addition, the number of occupancy sensors that are required to be reporting as 'occupied' before the system air handler is put into occupied mode is shown on this schedule

5-10.1 System default schedule

The System Default Schedule is configured in the System Scheduler by the Section UFGS 23 09 23 Contractor. This schedule is a '7-day' schedule. In other words, the schedule can differ by day of the week but not day of the year. This schedule should be as simple as possible with one set of times for weekdays and one for weekends. An extended Occupied mode is recommended and should encompass warm-up/cool-down times. For example, if the building is normally in Warm-Up from 0700-0800 and Occupied mode from 0800-1800, a reasonable default schedule might be for the building to be in Occupied mode from 0530-1930. When choosing times for the default schedules for systems with occupancy sensors, the Occupied mode times can be shorter since the occupancy sensors (or override buttons) can still put the system into an Occupied mode.

5-10.2 Supervisory monitoring and control schedule

The Supervisory Monitoring and Control (M&C) Schedule is configured at the M&C software by the UFGS 25 10 10 Contractor. Once a building is connected to the UMCS, this is the schedule that systems in the building will use. Although this schedule can include exceptions for holidays, it is recommended that the designer coordinate with the project site before requiring the implementation of these exceptions. Since the date of most holidays needs to be adjusted year-by-year, the project site O&M staff will need to reconfigure them yearly. As with the default schedule, the presence of Occupancy Sensors should be considered when choosing Occupied mode times.

5-10.3 Number of occupancy sensors to put AHU in occupied mode

Systems with occupancy sensors (or override buttons) can be placed into the Occupied mode by the occupancy sensors when a minimum number of occupancy sensors detect that the space they serve is occupied. Indicate the required number of occupancy sensors in this column.

CHAPTER 6

PROJECT IMPLEMENTATION

6-1 INTRODUCTION

This chapter describes the planning and design of a DDC project.

6-2 PLANNING

In addition to the guidance contained in this UFC, the design should be based on site-specific planning documents. Designs must be accomplished in accordance with the customer's site specific requirements such as, in the case of a Corps of Engineers project, the Installation Design Guide (IDG), Master Planning documents, and the UMCS/DDC Implementation Plan. To help obtain maximum benefit of Open DDC systems, designers should encourage their customers to develop a UMCS/DDC Implementation Plan. Development of an Implementation Plan is recommended in Engineering Construction Bulletin (ECB) 2007-8 and is described in ERDC/CERL Technical report TR-07-16 'IMCOM LONWORKS® Building Automation Systems Implementation Strategy'. This Technical Report is available at:

http://www.cecer.army.mil/techreports/ERDC-CERL_TR-07-16/ERDC-CERL_TR-07-16.pdf

PROCUREMENT CONSIDERATIONS

6-2.1 Non-proprietary procurement

Design of an LNS-based LonWorks® system that is compatible with a UMCS as described in this UFC is the preferred approach.

6-2.2 Proprietary procurement

Other approaches may require proprietary procurement and are therefore discouraged. Where a proprietary procurement approach is deemed necessary, possible proprietary procurement options include:

- Develop a five-year requirements contract.
- Develop contract documents for an Open system but indicate in the contract that, in lieu of an Open system, the Contractor may provide a proprietary DDC system compatible with the existing base-wide system. This requires two designs and two specifications.

- Develop a contract specification for a control system that is strictly "local" with no need to interface to a supervisory system. This approach is strongly discouraged for two reasons:
 - It results in a system that cannot readily be integrated later into a basewide UMCS.
 - Except for the most trivial control systems, a system without a supervisory front end, such as UMCS, will generally not meet customer needs for monitoring and control.

6-3 DDC DESIGN

6-3.1 General

The control system designer is responsible for specifying each control system required for the project systems and will incorporate the control loops and control system sequences of operation using the symbols, abbreviations, and acronyms designated in this guidance. This design responsibility requires producing a contract package that includes a specification and a set of drawings for each control system. While many implementation details will be left to the controls Contractor, the designer will not depend on the control system Contractor or vendor for the preparation of the contract package.

Much of the needed detail was attended to during the development of the UFGS and UFC criteria. Still, project specific requirements must be defined by the designer and the specifications and drawings edited accordingly. It also includes editing control schematic diagrams and other drawings. This notably includes, but is not limited to, editing the Points Schedule drawing to show critical Open system requirements. Some applications require the designer to size and select hardware requirements such as valve sizing and the selection of electric or pneumatic actuation.

The resultant project-specific specification will require the control system Contractor to produce shop drawings, schedules, instructions, test plans, test procedures, testing procedures, and other documents showing the application of products to implement the control system design. The specification will require the Contractor to implement the building-level CEA-709.1 communications network in a manner that is consistent with performance requirements defined in the specification. The specification will further require that the Contractor perform calibration, adjustments, and testing of the control system and document the testing to show that the control system functions as designed.

6-4 SCOPE OF THE DESIGN

UFC 3-410-02**19 Nov 2008**

The designer must assess the project specific requirements and tailor the design accordingly. This includes determination of whether the design should include a UMCS. The flowchart shown in Figure 6-1 and the following questions will aid in this decision.

- 1) It will be connected to a UMCS
 - a. Now
 - b. Later
- 2) It will not be connected to a UMCS

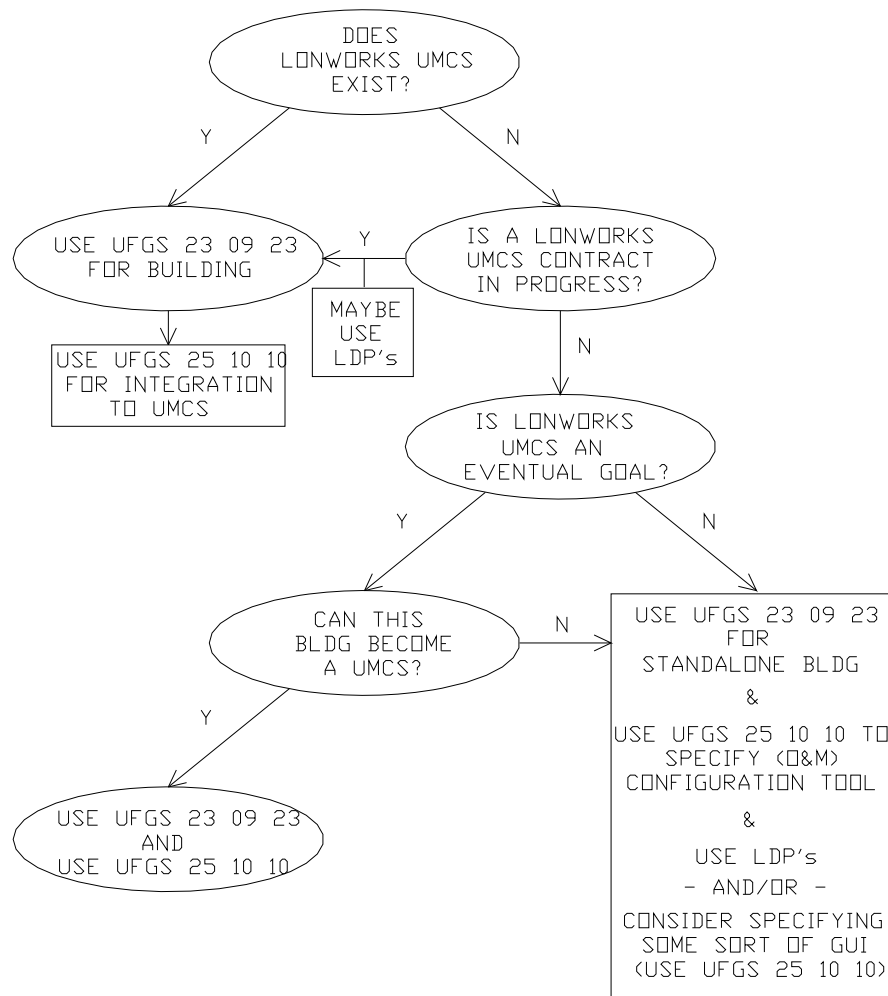


Figure 6-1. UMCS Decision Flow Chart.

Is there an existing LonWorks UMCS?

Yes: Use DDC UFGS 23 09 23 for the present building-level project and use an edited version of UMCS UFGS 25 10 10 to specify the integration of the building system to the UMCS (UMCS UFGS 25 10 10 is designed to make this editing task straightforward).

No: Determine if there is a LonWorks UMCS contract in-progress.

Is a LONWORKS UMCS contract in-progress?

For example, another 'in-progress' project might include a UMCS or development of an IDIQ contract for a basewide UMCS might be in 'in-progress'.

Yes: Assuming the intent is to eventually interface the present building-level (DDC UFGS 23 09 23) system with the future UMCS, the 'in-progress' building-level DDC systems (DDC UFGS 23 09 23) can later be interfaced to the UMCS (upon installation of the future UMCS) using an edited version of UMCS UFGS 25 10 10 as described above.

To provide additional interim functionality to the building until the UMCS integration can occur, the designer might choose to include local display panels (LDPs) in the present project to serve as an O&M tool until the UMCS contract provides Monitoring and Control software and a network configuration tool. Alternatively, the designer might choose to include a network configuration tool (from UMCS UFGS 25 10 10) in the present DDC UFGS 23 09 23 contract specification along with the accompanying workstation (laptop computer) required to run the (software) tool while bearing in mind that the UMCS will also include a configuration tool.

No: Decide if a LONWORKS UMCS is an eventual goal.

Is a LONWORKS UMCS an eventual goal?

If Yes, **Can this building become 'a UMCS'**? Essentially any building system project can become a UMCS by including UMCS UFGS 25 10 10 in the project specification with only an incremental investment over a single-building standalone system. In this case, use both DDC UFGS 23 09 23 and UMCS UFGS 25 10 10 in its entirety to obtain a UMCS (but see the discussion of contracting options below).

At its most basic level, the creation of a UMCS consists of adding: a UMCS workstation, M&C software, a network configuration tool, a BPOC, and an Ethernet backbone for connection to the UMCS workstation. In addition, it is wise to pre-plan a contractual support mechanism, such as an IDIQ or Services contract, to support expansion of the UMCS as new buildings are added to the UMCS (see discussion of contracting options below).

Some additional planning and/or design may be required such as providing space for the UMCS workstation, server, and printers. Consideration might need to be given to identifying desirable added functionality that might otherwise not be included in the absence of a UMCS such as the inclusion of workstation graphical displays or the addition of client workstations. Many of these things are ordinarily addressed as part of a UMCS/DDC Master Plan. In summary, adding UMCS requirements as part of a single-building system provides a single-building system that may serve as the basis for all future system expansions where subsequent buildings and systems can be integrated with this first system. This is the first step towards a basewide UMCS.

No: If **this building cannot become a UMCS**, use DDC UFGS 23 09 23 to specify a standalone building by using applicable portions of UMCS UFGS 25 10 10 to specify

M&C software and O&M tool requirements. For the operator interface, use LDPs as specified in DDC UFGS 23 09 23 and/or consider specifying some sort of graphical user interface (GUI), such as that specified under Monitoring and Control software in UFGS 25 10 10. You must also specify a configuration tool such as that specified in UMCS UFGS 25 10 10. The LDPs, GUI/M&C software, and configuration tool are necessary for O&M of the stand alone DDC system. While UMCS UFGS 25 10 10 is primarily intended for implementing a basewide UMCS, it also pertains to smaller scale applications including a single system or single building. In this case, UMCS UFGS 25 10 10 is necessary to obtain operator workstation (desktop or laptop) interface tools required by the O&M support staff. Edit UMCS UFGS 25 10 10 to provide the required functionality and tools. Using only DDC UFGS 23 09 23 is inadvisable. DDC UFGS 23 09 23 does not contain operator interface requirements/devices except for a local display panel which is not sufficient to adequately support O&M activities. Tools necessary to support O&M activities such as an operator workstation (laptop) will not be provided.

6-5 CONTRACTING MECHANISMS

While procurement of building level controls is relatively straightforward, procurement of a UMCS is more complex. There are two main issues to be considered:

- UMCS work is an ongoing process. While the UMCS is procured once, building integration to the UMCS is a process that can span many years. The question of how to accomplish future integration work should be addressed prior to initial procurement. As an extreme example, there are “mom-and-pop” shops that can install a custom UMCS that they have developed themselves. However, use of such a UMCS pretty much guarantees that future integration work will have to be performed by the “mom-and-pop” shop.
- Contractually, it might be easiest to procure the initial UMCS from a building level DDC Contractor as part of a building level DDC controls project. The danger in this approach is that allowing the same Contractor to install both requires extra vigilance on the part of the government to ensure that the interface between the UMCS and the building is fully compliant with UMCS UFGS 25 10 10. As an extreme case, the Contractor might install a UMCS that works fine with the Contractor’s controls, but will not work with other building control systems that are compliant with DDC UFGS 23 09 23.

There are a number of contracting mechanisms that can be used, including:

- IDIQ or services contract.
- As part of a building level DDC contract.
- As a separate contract for either UMCS procurement or integration services.

A detailed discussion of contracting methods and the pros and cons of each can be found in ERDC/CERL Technical Report TR-07-16 'IMCOM LONWORKS® Building Automation Systems Implementation Strategy' at <https://eko.usace.army.mil/fa/bas/>.

6-6 COORDINATION

6-6.1 IT (DOIM) Coordination

- Coordinate with the project site's Internet Technology (IT) group such as the Directorate of Information Management (DOIM) and with the UMCS UFGS 25 10 10 designer as applicable. The designer must specify the Building Point of Connection (BPOC) location, where the intent is to obtain UFGS 23 09 32 Contractor-provided TP/FT-10 building control network wiring that extends to the location of the BPOC. Ordinarily, in accordance with UMCS UFGS 25 10 10, the BPOC will be provided by the UMCS Contractor.
- A major issue for installation of a UMCS will be DIACAP and Networkiness certifications. Current Army regulations require that any Army information system be covered by DIACAP and that any system residing on the basewide IP network have a certificate of Networkiness. Fortunately, except in the infrequent case of a DDC IP network in the building, DIACAP and Networkiness do not impact installation of building-level DDC controls since they reside on a TP/FT-10 network, not IP. DIACAP and Networkiness are discussed in further detail in UFC 3-401-01, UTILITY MONITORING AND CONTROL SYSTEM (UMCS).

6-6.2 Mechanical design coordination

- Coordinate mechanical systems design with control system requirements.
- Coordinate outside air (OA) ducts. Most air systems will require a minimum OA duct/damper (for ventilation or make-up air) separate from the economizer OA duct.
- Coordinate/show outside air temperature location(s) on the M-plates.
- Coordinate/show room sensor locations on M-plates.
- Coordinate duct and pipe mount sensor locations and show on M-plates. The primary goal is to help ensure that the mechanical design accommodates control instrumentation space, distance, and access needs. A secondary goal is to ensure that the M-plates document instrument locations and other details to help ensure proper installation and to provide O&M documentation. This includes air flow measurement arrays (AFMAs), static pressure sensors, and relative humidity sensors. AFMAs generally should be located at least eight straight duct diameters downstream of obstructions and three diameters upstream. Duct static

pressure sensors should be located near the end of the longest branch duct. Duct relative humidity sensors should be located three meters downstream of an injection element. Piping differential sensors should be located towards the end of the piping system. The specifications provide specific Contractor guidance.

- Coordinate air flow measurement requirements such as those for VAV systems to provide upstream air filters, airflow station access door, and clearance for O&M access.
- Coordinate air compressor and dryer locations with mechanical designer.
- Make sure mechanical designer is providing clearance/access space to mechanical equipment for DDC UFGS 23 09 23 Contractor and O&M
- Coordinate interface to boilers, chillers, and other package units. Identify interface type. Edit chiller/boiler specs.

6-6.3 Electrical design coordination

- Make sure 120Vac power is available in all mechanical rooms and at terminal units for controls Contractor use to provide power to instrumentation and controls.
- Make sure there is power in the proper location for the air compressor based on estimated compressor size (horsepower). Provide an estimate of the air compressor size.
- Occupancy sensor interface to electrical systems. Where occupancy sensors will be interfaced with lighting systems/ballasts, identify possible concerns or issues.
- Where a variable frequency drive is required ensure that there is a VFD specification and that it meets the application requirements as defined in the sequence of operation and ladder diagram drawing. In particular, note the fire alarm panel interface and H-O-A switch requirements.
- Identify the location of the UMCS building point of connection (BPOC).

6-6.4 Project site coordination

Coordination details are described throughout this UFC. A short list of coordination activities includes:

- Pneumatic versus electric actuation. Decide which to use. Consider the actuation needs in both mechanical rooms and at terminal units in the zones/spaces.

- Valve type preferences.
- Need for local display panel (LDP). Decide if LDPs are desired/required.
- Wire and cable. Need for raceway/conduit.
- Default system schedule and Terminal Unit (TU) groupings. When a UMCS is used it will perform (primary) scheduling but in the absence (or loss) of a UMCS a 'default schedule' will be active. Identify the default system schedule to be used for each piece of scheduled equipment. In addition, determine if it is desirable to use a common schedule for multiple TUs and identify this schedule.
- Point naming conventions and device addressing conventions.
- Reset buttons. Decide how to implement DDC reset. Refer to Drawings Chapter and show selection on the Points Schedule.
- Occupancy sensors. Occupancy sensor signal is used to turn the servicing AHU 'on'. Decide how many sensors must generate an occupied signal (from multiple spaces) to help avoid needless turning on of the servicing AHU (due to cleaning staff or security staff passing through after hours).
- Stats / space sensors: Select desired functionality including pushbutton override and occupancy sensor time delay. Show in the Schedule drawing.
- Filter pressure switches. Decide if these are required.
- Training. Identify number of students, number of hours of training, and number of copies of training material.

6-7 EDITING THE SPECIFICATION

6-7.1 UFGS 23 09 23 edits

Make selections/entries according to designer brackets "[]". Notes are provided in the specification to assist with these selections.

6-7.2 Other specification editing/coordination

- Smoke detectors. Coordinate with applicable specification(s).
- Foundation/housekeeping pad specs.
- Performance verification test (PVT). Edit PVT requirements to be project specific.

UFC 3-410-02

19 Nov 2008

- As identified in paragraphs “Electrical design coordination” and “Mechanical design coordination”.

6-8 DRAWING PACKAGE

Assemble and edit the drawing package as described in CHAPTER 5.

6-9 OTHER

Perform a biddability, constructability, operability, and environmental (BCOE) review.

APPENDIX A GLOSSARY

10Base-T	Ethernet media and communication speeds. The number is communication speed in Megabits per second (Mbps) or Gigabits per second (Gbps). "T" is twisted pair wire (usually Cat-5 or better), while "FX", "SX", and "LX" are fiber optic cable. Note that 10 Gigabit Ethernet is (as of 2006) an IEEE standard and 100 Gigabit Ethernet is in development.
100Base-T	
100Base-FX	
1000Base-T	
1000Base-SX	
1000Base-LX	
10GBase-T	
AGC	Application Generic Controller. A controller that comes from the factory with a limited built-in application. It is <i>programmed</i> for the application (VAV box, fan coil, etc.). It can be programmed through an LNS plug-in. It can be thought of as a cross between an ASC and GPPC. These controllers should be certified by Lon Mark. An AGC has a fixed program ID.
ASC	Application Specific Controller. A controller that has a built-in, fixed program to execute a sequence for a specific hardware system, e.g. a VAV box controller. An ASC controller has a fixed program ID.
Building Point of Connection (BPOC)	The BPOC is the point of connection between the UMCS network backbone (an IP network) and the building control network backbone. The hardware at this location that provides the connection is referred to as the BPOC Hardware. In general, the term "BPOC Location" means the place where this connection occurs, and "BPOC Hardware" means the device that provides the connection. Sometimes the term "BPOC" is used to mean either and its actual meaning (i.e. location or hardware) is determined by the context in which it is used.
Closed	The opposite of Open. A standard/protocol/specification where important details of its implementation are not available to all interested parties. Closed standards are closely controlled by the developing party and implementation of devices based on them is generally limited to a small number of vendors.
Configured Setpoint	As opposed to a user-adjustable setpoint like that provided by a thermostat, a configured setpoint is set at the DDC hardware by a configuration tool (software). Although they can be changed later through the configuration tool, these setpoints are more "permanent" than a user-adjustable setpoint.
Device	A piece of hardware. See also 'Node'.

DDC	Direct Digital Control, defined as control consisting of microprocessor-based controls with the control logic performed by software.
Gateway	A device (usually a combination of software and hardware) that connects networks using different communication protocols so that information can be passed from devices on one network to the other. Gateways perform protocol conversion to translate this information from one protocol to another.
GPPC	General Purpose Programmable Controller. A controller that can be programmed to run any (within hardware limits) sequence and can be set up as a controller for different hardware systems. Changes to the program result in a different Program ID.
GUI	Graphical User Interface. A program interface that takes advantage of the computer's graphics capabilities to make the program easier to use. A true GUI includes formats for representing text and graphics.
HMI	Human-Machine Interface: The means by which an operator interacts with an automation system, often a GUI.
Interoperability	The ability to integrate products from multiple vendors into flexible, functional systems without the need to develop custom hardware, software, or tools.
Interoperable	This is closely related to Open standards and refers to the level of difficulty of integrating components (or systems) from multiple vendors into a single system. Interoperability needs to be considered from the perspective of hardware installation (will the parts physically fit and interconnect?), communications (do the devices "speak the same language"?), configuration and programming (is the same software tool used for different vendor components?), maintainability (do the components have similar maintenance procedures and requirements?), and operation (do the components have similar functionality/sequences and utilize the same operator interface?). Open standards enhances/encourages interoperability because it allows multiple vendors to utilize a common standard. A caveat: In many (if not all cases), when vendors use the term interoperable, they do not mean <i>interchangeable</i> (in the sense of swapping out a VAV box for an identical VAV box).
IP	Internet Protocol. IP is a protocol on the Internet and is concerned with addressing and routing of data packets from their origin to the destination. Many other protocols are used in the Internet (TCP, HTTP, etc), but IP is the key protocol the others run on top of.
LAN	Local Area Network, is a network for transferring data between computers or other digital devices.

LNS®	LonWorks Network Service, is the database architecture that resides on the computer attached to the LonWorks Network that is used to install and manage the Network. LNS is a database that can be accessed by any LNS-based Network Configuration Tool and by multiple users simultaneously.
LON	Local Operating Network. Also used as a shorthand reference to the term LonWorks.
LonTalk®	A networking protocol developed by Echelon Corporation and recognized by ANSI/CEA as ANSI/CEA-709.1-B. LonTalk implements layers 1-6 of the OSI reference model.
LonWorks®	A networking platform (created by Echelon Corporation) that provides solutions to numerous problems of designing, building, installing, and maintaining control networks.
LonWorks Router	A piece of equipment that allows ANSI/CEA-709.1-A communication and routing of network variables over an ANSI/CEA-709.1-A network. See "Router".
LonWorks LON to IP Router	A piece of equipment that allows ANSI/CEA-709.1 communication and routing of network variables over IP. Also known as an ANSI/CEA 852 router. See "Router".
Network	A group of devices (computers, controllers, or other digital units) that are connected by communication facilities, such as twisted-pair cabling, coaxial cable, fiber-optic cable, or wireless means.
Network Configuration Tool	The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).
Neuron® C	A derivative of the C programming language specifically designed for developing applications for the Neuron chip.
Neuron® chip	A chip that implements the ANSI/CEA-709.1 protocol. This chip is used by most LonWorks devices for communication on the network. Many LonWorks devices also use this chip for control functionality.
Node	A device (such as a computer or a controller) on a network that is capable of communicating with other network devices via a networking protocol such as ANSI/CEA-709.1.
Open system	An Open system is characterized by the ability for any qualified third party entity to readily modify, operate, upgrade, and perform retrofits on the system.

UFC 3-410-02**19 Nov 2008**

OWS	Operator Work Station, a type of computer-based GUI. An OWS is designed for use by an operator whereas a technician or maintenance worker might have a different computer and GUI with a different “look and feel”.
Peer-to-Peer	A type of network where each node has equivalent capabilities and responsibilities for network communication.
Plug-in	Software used to configure an ASC that is run/executed from within a Network Configuration Tool.
Program ID	All DDC controllers have a firmware-based program inside them that allows them to execute their function. For CEA-709.1 controllers, this program has a Program ID that is unique to that particular program. Changing the program results in a different Program ID. Program IDs may be used to ensure that 2 controllers have the same program.
Proprietary	Privately owned and controlled. Proprietary is the opposite of public domain.
Proprietary – Government procurement	In Government procurement regulations, a proprietary product is one that requires sole source procurement.
Router	A device that connects two or more LANs. Routers are devices that provide network-independent packet filtering and forwarding. They may also include bridge functionality.
SNVT	Standard Network Variable Type; Pronounced 'snivet'. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual LonWorks nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.
Standard, De-Facto	De-Facto standards are ‘standards of fact’, that is, standards that have been adopted by an industry or a market. An example of a de-facto standard is Microsoft Word. While it has not been adopted by a recognized standards organization, its market dominance makes it the de-facto standard for word processing. Gray areas arise here over market share and industry recognition.

UFC 3-410-02**19 Nov 2008****Standard, De-Jurie**

De-Jurie standards (literally, 'standards of law') are those that have been adopted and approved by some recognized standards organization, such as ASHRAE, IEEE, ASTM, ISO, etc. CEA-709.1 is an example of a de-jurie standard. Gray areas can arise here over what constitutes a standards body.

Standard, Proprietary

Proprietary standards are those that are owned and controlled by an organization not generally recognized as a 'legitimate' standards body (they are often owned by a for-profit organization). They frequently are considered to be, or to contain, intellectual property of value to the owning body. Proprietary standards may be Open, closed, or somewhere in between, though they tend to be more closed. The Microsoft Word document format (.doc files) is an example of a closed proprietary standard.

Transceiver

A component or circuit that enables a hardware device to communicate on a network.

APPENDIX B

CONTROL LOGIC DIAGRAM (CLD) TUTORIAL

Planned edits:

1. fix binary vs analog line thickness problem
2. add PID loop figure
3. add IF figure
4. add set/reset figure
5. add ramp up and ramp down block
6. fix Figure B-1 Control Logic Diagram for Central Plant Hydronic with Steam/HW Converter – replace with updated

B-1 INTRODUCTION

The control logic diagram (CLD) is an unambiguous graphical description of the control system sequence of operation. The focus of the CLD is on control logic, not on a particular hardware implementation. In particular, the CLD does not distinguish between normally open or normally closed contacts, valves, or dampers; these details should instead be indicated on the appropriate wiring diagram, valve/damper schedule, or control schematic drawing. The CLD is concerned with whether a given signal is TRUE or FALSE.

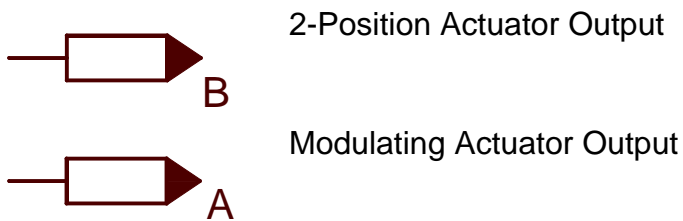
For example, a typical sequence calls for a 'fan status' input (to be used in a fan-proof logic block). The actual hardware could be implemented in a variety of ways, -- a current-sensing-relay on the fan motor, a DP switch across the fan, or an air flow proof switch. The actual hardware used is irrelevant to the CLD. Any one of these possible hardware devices would be shown as a simple binary input to the sequence. Another example would be the freeze stat (CoolinG-Discharge-Air-Temp-LowLimit; CLG-DA-T-LL) which is TRUE when the freeze stat trips; whether that's from a set of NO or NC contacts is a detail for the wiring diagram. Finally, the Controller hardware implementation is not shown; while a given functional block is probably implemented in one controller, a build-up system (such as a RF VAV system with MA Economizer and Ventilation Demand control) may be in one or more controllers – the CLD does not make that distinction.

B-2 FUNCTIONAL BLOCKS USED IN CONTROL LOGIC DIAGRAMS

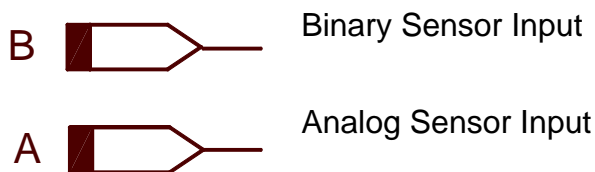
In the following descriptions, logical values are always referred to as TRUE or FALSE. Synonyms for these names include ON and OFF, as well as 1 and 0.

B-2.1 Signal

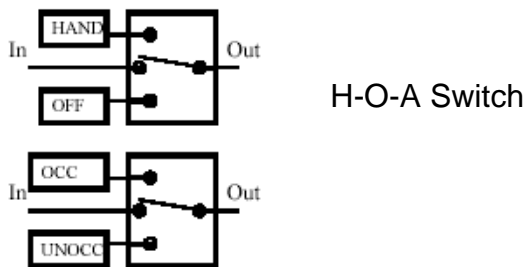
A line represents a signal path within the logic, either analog or binary. This line shows signal inputs and/or outputs to and from functional blocks.

B-2.2 Actuator Output

This block represent a physical output from the system, an actuator or valve. It accepts a binary (B) or analog (A) signal and drives a piece of hardware. Since the CLD shows the control logic without reference to the hardware implementation, the actual hardware is unspecified.

B-2.3 Sensor Input

This block represents a hardware sensor input to the system. It may provide either an analog (A) or binary (B) signal. Again, the exact hardware type is unspecified.

B-2.4 Hand-Off-Auto (H-O-A) Switch

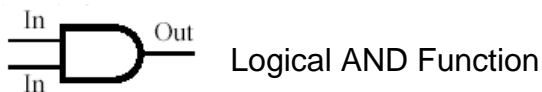
This represents a HAND-OFF-AUTO switch. Sometimes, a H-O-A switch will be shown differently; for example where the position of the H-O-A switch would select some input to control logic. This block is generally used when the output of a control block is selected. The top block shows a normal H-O-A switch, the bottom shows a variant where the manually selected values are OCCUPIED or UNOCCUPIED.

B-2.5 Constant Value

This logic block represents a constant value, either analog or binary and is usually provided as an input to another logic block.

B-2.6 Signal I/O

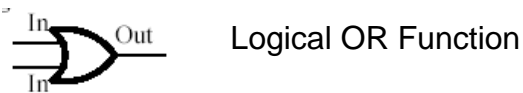
These blocks represent a named signal path within the logic. These are functionally identical to the symbols described earlier, except that this signal is given a name, which allows it to be defined or used elsewhere in the logic.

B-2.7 Logical AND

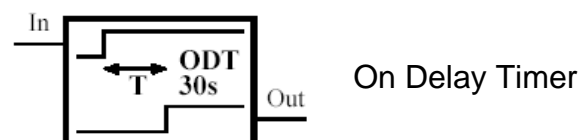
This logic block represents the logical AND function. It takes two or more binary inputs and produces a binary output. Its output is TRUE if and only if all of its inputs are TRUE. If any of its inputs are FALSE, then its output is FALSE.

B-2.8 Logical NOT

This logic block represents the logical NOT function. It has one binary input and one binary output. Its output is TRUE if and only if its input is FALSE. If its input is TRUE, its output is FALSE.

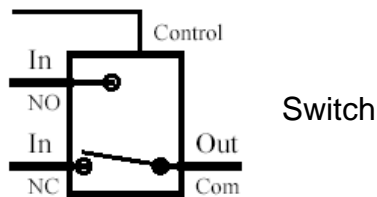
B-2.9 Logical OR

This logic block represents the logical OR function. It has two or more binary inputs and one binary output. Its output is TRUE if any of the inputs are true. If all the inputs are FALSE, the output is FALSE.

B-2.10 On Delay Timer

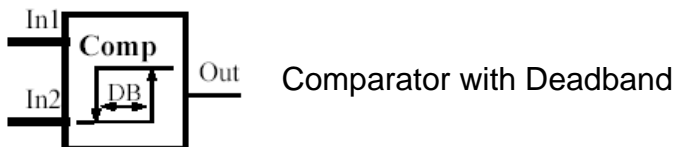
This logic block represents an On Delay Timer. It has one binary input and one binary output. In addition it has one parameter, a time (T) value. The output is always equal to the input, except when the input changes value from FALSE to TRUE. In this case, the transition of the output from FALSE to TRUE is delayed by the value of the time parameter. This time value has no effect on the transition from TRUE to FALSE, it only affects the output when the input becomes TRUE.

B-2.11 Switch



This block represents an analog switch with 2 analog inputs, one analog output, and a binary control input. When the control input is false, the output is the value of the analog signal at the Normally Closed (NC) input. When the control input is true, the output is the value of the analog signal at the NO (Normally Open) input. Note that this convention for NC and NO follows the electrical switch convention; it is opposite from that used for pneumatic switches.

B-2.12 Comparator with Deadband



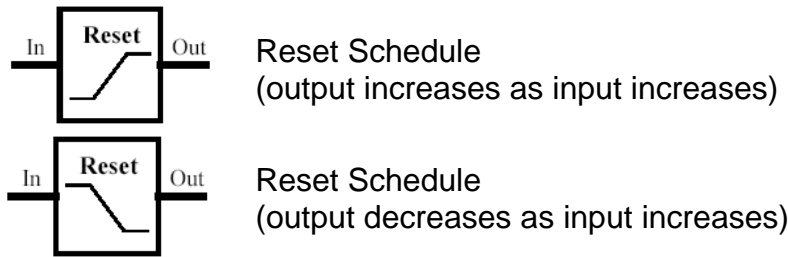
This logic block represents a comparator function with hysteresis. It takes two analog inputs and produces a binary output. It also has one parameter, deadband (DB). As shown in Comparator Table below the output value only changes if the difference between the inputs exceeds half the deadband, if the difference in inputs is less than half the deadband, the output remains at its present value.

Comparator Input and Corresponding Output

Input Conditions	Output Value
$(In1 - In2) < -deadband/2$	FALSE
$-deadband/2 \leq (In1 - In2) \leq deadband/2$	Output does not change; remains fixed
$(In1 - In2) > +deadband/2$	TRUE

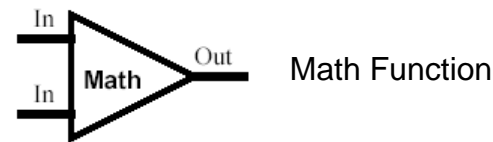
For example, if $In1=75$, $In2=68$ and the $deadband=4$, the output would be TRUE. As $In1$ fell, the output would remain TRUE until $In1$ went below 66 ($68 - 66 = 4/2$). Essentially, the output of this block is TRUE if the top value is greater than the bottom value and FALSE if the bottom value is greater than the top value (neglecting the deadband).

B-2.13 **Reset Schedule**



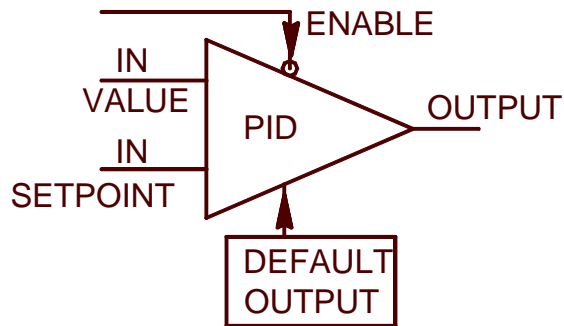
This block represents a reset schedule. It has one analog input, one analog output, and 4 parameters: InputMin, InputMax, OutputMin, and OutputMax. For the first reset schedule shown, the output increases as the input increases; as the input ranges from InputMin to InputMax, the output varies linearly from OutputMin to OutputMax. Inputs below InputMin or above InputMax result in the output going to OutputMin or OutputMax, respectively. For the second reset schedule shown, the output decreases as the input increases. The reset schedule block can be thought of as a graph, with the input variable on the X-axis and the output variable on the Y-axis.

B-2.14 **Math Function**



This logic block represents a variety of mathematical functions. It takes two or more analog inputs and produces an analog output. Some common functions for this block are shown in the table below.

Common Math Block Functions	
Name	Function
Minus	Subtraction
Minimum	Select the minimum value from the input values
Maximum	Select the maximum value from the input values
Plus	Addition

B-2.15 PID Loop with Enable

This function block represents a proportional-integral-derivative (PID) loop with an Enable input. It has 2 analog inputs (a value and a setpoint), an analog output, a binary enable input, and default output. The DEFAULT OUTPUT is the OUTPUT when the ENABLE is false.

B-2.15.1 IF Block

The IF Block is TRUE if the input meets the condition inside the block, otherwise the IF Block's output is FALSE.

B-2.15.2 Set/Reset Latch

This function block represents a latch. The latch has 2 binary inputs, a set input and a reset input, as well as a single binary output. Once set (by a TRUE value at the Set input), the latch's output remains TRUE until reset (by a TRUE value at the reset input). Likewise, once reset, the output remains FALSE until set by a TRUE value at the set input. Essentially, the latch remembers whether it was last Set or Reset.



REQUEST FOR PROPOSAL



APPENDIX-FF

BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC

USACE / NAVFAC / AFCEA / NASA UFGS-23 09 23.13 20 (August 2009)

Preparing Activity: NAVFAC Superseding
 UFGS-23 09 23.13 20 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2010

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 23 09 23.13 20

BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC

08/09

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 DEFINITIONS
 - 1.2.1 ANSI/ASHRAE Standard 135
 - 1.2.2 ARCNET
 - 1.2.3 BACnet
 - 1.2.4 BACnet/IP
 - 1.2.5 BACnet Internetwork
 - 1.2.6 BACnet Network
 - 1.2.7 BACnet Segment
 - 1.2.8 BBMD
 - 1.2.9 BAS
 - 1.2.10 BAS Owner
 - 1.2.11 BIBBs
 - 1.2.12 BI
 - 1.2.13 BI/BTL
 - 1.2.14 Bridge
 - 1.2.15 Broadcast
 - 1.2.16 Device
 - 1.2.17 Device Object
 - 1.2.18 Device Profile
 - 1.2.19 Digital Controller
 - 1.2.20 Direct Digital Control (DDC)
 - 1.2.21 DDC System
 - 1.2.22 Ethernet
 - 1.2.23 Firmware
 - 1.2.24 Gateway
 - 1.2.25 Half Router
 - 1.2.26 Hub
 - 1.2.27 Internet Protocol (IP, TCP/IP, UDP/IP)
 - 1.2.28 Input/Output (I/O)
 - 1.2.29 I/O Expansion Unit
 - 1.2.30 IP subnet

- 1.2.31 Local-Area Network (LAN)
- 1.2.32 LonTalk
- 1.2.33 MAC Address
- 1.2.34 Master-Slave/Token-Passing (MS/TP)
- 1.2.35 Native BACnet Device
- 1.2.36 Network
- 1.2.37 Network Number
- 1.2.38 Object
- 1.2.39 Object Identifier
- 1.2.40 Object Properties
- 1.2.41 Peer-to-Peer
- 1.2.42 Performance Verification Test (PVT)
- 1.2.43 PID
- 1.2.44 PICS
- 1.2.45 Points
- 1.2.46 PTP
- 1.2.47 Repeater
- 1.2.48 Router
- 1.2.49 Stand-Alone Control
- 1.3 SUBCONTRACTOR SPECIAL REQUIREMENTS
- 1.4 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC DESCRIPTION
 - 1.4.1 Design Requirements
 - 1.4.1.1 Control System Drawings Title Sheet
 - 1.4.1.2 List of I/O Points
 - 1.4.1.3 Control System Components List
 - 1.4.1.4 Control System Schematics
 - 1.4.1.5 HVAC Equipment Electrical Ladder Diagrams
 - 1.4.1.6 Component Wiring Diagrams
 - 1.4.1.7 Terminal Strip Diagrams
 - 1.4.1.8 BACnet Communication Architecture Schematic
- 1.5 SUBMITTALS
- 1.6 QUALITY ASSURANCE
 - 1.6.1 Standard Products
 - 1.6.2 Delivery, Storage, and Handling
 - 1.6.3 Operating Environment
 - 1.6.4 Finish of New Equipment
 - 1.6.5 Verification of Dimensions
 - 1.6.6 Contractor's Qualifications
 - 1.6.7 Modification of References
 - 1.6.8 Project Sequence

PART 2 PRODUCTS

- 2.1 DDC SYSTEM
 - 2.1.1 Direct Digital Controllers
 - 2.1.1.1 I/O Point Limitation
 - 2.1.1.2 Environmental Limits
 - 2.1.1.3 Stand-Alone Control
 - 2.1.1.4 Internal Clock
 - 2.1.1.5 Memory
 - 2.1.1.6 Immunity to Power Fluctuations
 - 2.1.1.7 Transformer
 - 2.1.1.8 Wiring Terminations
 - 2.1.1.9 Input and Output Interface
 - 2.1.1.10 Digital Controller BACnet Internetwork
 - 2.1.1.11 Communications Ports
 - 2.1.1.12 Modems
 - 2.1.1.13 BACnet Gateways
 - 2.1.1.14 Digital Controller Cabinet

- 2.1.1.15 Main Power Switch and Receptacle
- 2.1.2 DDC Software
 - 2.1.2.1 Programming
 - 2.1.2.2 Parameter Modification
 - 2.1.2.3 Short Cycling Prevention
 - 2.1.2.4 Equipment Status Delay
 - 2.1.2.5 Run Time Accumulation
 - 2.1.2.6 Timed Local Override
 - 2.1.2.7 Time Synchronization
 - 2.1.2.8 Scheduling
 - 2.1.2.9 Object Property Override
 - 2.1.2.10 Alarms and Events
 - 2.1.2.11 Trending
 - 2.1.2.12 Device Diagnostics
 - 2.1.2.13 Power Loss
- 2.1.3 BACnet Operator Workstation
 - 2.1.3.1 BACnet Operator Workstation Hardware
 - 2.1.3.2 Password Protection
 - 2.1.3.3 BACnet Operator Workstation DDC Software
 - 2.1.3.4 Graphics Software
- 2.1.4 Notebook Computer
- 2.1.5 BACnet Protocol Analyzer
- 2.2 SENSORS AND INPUT HARDWARE
 - 2.2.1 Field-Installed Temperature Sensors
 - 2.2.1.1 Thermistors
 - 2.2.1.2 Resistance Temperature Detectors (RTDs)
 - 2.2.1.3 Temperature Sensor Details
 - 2.2.2 Transmitters
 - 2.2.2.1 Relative Humidity Transmitters
 - 2.2.2.2 Pressure Transmitters
 - 2.2.3 Current Transducers
 - 2.2.4 Pneumatic to Electric Transducers
 - 2.2.5 Air Quality Sensors
 - 2.2.5.1 CO2 Sensors
 - 2.2.5.2 Air Quality Sensors
 - 2.2.6 Input Switches
 - 2.2.6.1 Timed Local Overrides
 - 2.2.7 Freeze Protection Thermostats
 - 2.2.8 Air Flow Measurement Stations
 - 2.2.9 Energy Metering
 - 2.2.9.1 Electric Meters
 - 2.2.9.2 Steam Meters
- 2.3 OUTPUT HARDWARE
 - 2.3.1 Control Dampers
 - 2.3.2 Control Valves
 - 2.3.2.1 Valve Assembly
 - 2.3.2.2 Butterfly Valves
 - 2.3.2.3 Two-Way Valves
 - 2.3.2.4 Three-Way Valves
 - 2.3.2.5 Valves for Chilled Water, Condenser Water, and Glycol Fluid Service
 - 2.3.2.6 Valves for Hot Water Service
 - 2.3.2.7 Valves for High Temperature Hot Water Service
 - 2.3.2.8 Valves for Steam Service
 - 2.3.3 Actuators
 - 2.3.3.1 Electric Actuators
 - 2.3.3.2 Pneumatic Actuators
 - 2.3.4 Output Signal Conversion
 - 2.3.4.1 Electronic-to-Pneumatic Transducers

- 2.3.5 Output Switches
 - 2.3.5.1 Control Relays
- 2.4 ELECTRICAL POWER AND DISTRIBUTION
 - 2.4.1 Transformers
 - 2.4.2 Surge and Transient Protection
 - 2.4.2.1 Power Line Surge Protection
 - 2.4.2.2 Telephone and Communication Line Surge Protection
 - 2.4.2.3 Controller Input/Output Protection
 - 2.4.3 Wiring
 - 2.4.3.1 Power Wiring
 - 2.4.3.2 Analog Signal Wiring
- 2.5 FIRE PROTECTION DEVICES
 - 2.5.1 Duct Smoke Detectors
- 2.6 INDICATORS
 - 2.6.1 Thermometers
 - 2.6.2 Pressure Gauges for Piping Systems
 - 2.6.3 Pressure Gauges for Pneumatic Controls
- 2.7 PNEUMATIC POWER SUPPLY AND TUBING
 - 2.7.1 Air Compressors
 - 2.7.1.1 Compressed Air Tank
 - 2.7.2 Refrigerated Air Dryers
 - 2.7.3 Compressed Air Discharge Filters
 - 2.7.4 Air Pressure-Reducing Stations
 - 2.7.5 In-line Filters
 - 2.7.6 Pneumatic Tubing
 - 2.7.6.1 Copper Tubing
 - 2.7.6.2 Polyethylene Tubing
- 2.8 VARIABLE FREQUENCY (MOTOR) DRIVES
 - 2.8.1 VFD Quality Assurance
 - 2.8.2 VFD Service Support
 - 2.8.3 VFD Features
 - 2.8.4 Programmable Parameters
 - 2.8.5 Protective Features
 - 2.8.6 Minimum Operating Conditions
 - 2.8.7 Additional Features

PART 3 EXECUTION

- 3.1 INSTALLATION
 - 3.1.1 BACnet Naming and Addressing
 - 3.1.2 Minimum BACnet Object Requirements
 - 3.1.3 Minimum BACnet Service Requirements
 - 3.1.4 Local Area Networks
 - 3.1.5 BACnet Routers, Bridges, and Switches
 - 3.1.6 Wiring Criteria
 - 3.1.7 Accessibility
 - 3.1.8 Digital Controllers
 - 3.1.9 Hand-Off-Auto Switches
 - 3.1.10 Temperature Sensors
 - 3.1.10.1 Room Temperature Sensors
 - 3.1.10.2 Duct Temperature Sensors
 - 3.1.10.3 Immersion Temperature Sensors
 - 3.1.10.4 Outside Air Temperature Sensors
 - 3.1.11 Energy Meters
 - 3.1.12 Damper Actuators
 - 3.1.13 Thermometers and Gages
 - 3.1.14 Pressure Sensors
 - 3.1.15 Pneumatic Tubing
 - 3.1.16 Component Identification Labeling

- 3.1.17 Network and Telephone Communication Lines
- 3.2 TEST AND BALANCE SUPPORT
- 3.3 CONTROLS SYSTEM OPERATORS MANUALS
 - 3.3.1 Storage Cabinets
- 3.4 PERFORMANCE VERIFICATION TESTING (PVT)
 - 3.4.1 General
 - 3.4.2 Performance Verification Testing Plan
 - 3.4.3 PVT Sample Size
 - 3.4.4 Pre-Performance Verification Testing Checklist
 - 3.4.5 Conducting Performance Verification Testing
 - 3.4.6 Controller Capability and Labeling
 - 3.4.7 Workstation and Software Operation
 - 3.4.8 BACnet Communications and Interoperability Areas
 - 3.4.9 Execution of Sequence of Operation
 - 3.4.10 Control Loop Stability and Accuracy
 - 3.4.11 Performance Verification Testing Report
- 3.5 TRAINING REQUIREMENTS
 - 3.5.1 Training Documentation
 - 3.5.2 Phase I Training - Fundamentals
 - 3.5.3 Phase II Training - Operation

-- End of Section Table of Contents --

USACE / NAVFAC / AFCEA / NASA UFGS-23 09 23.13 20 (August 2009)

Preparing Activity: NAVFAC Superseding
 UFGS-23 09 23.13 20 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2010

SECTION 23 09 23.13 20

BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC 08/09

NOTE: This guide specification covers the Navy requirements for direct digital control (DDC) of heating, ventilating, and air conditioning (HVAC) systems complying with ANSI/ASHRAE Standard 135, "BACnet - A Data Communication Protocol for Building Automation and Control Networks." BACnet is also an international standard, ISO 16484-5. The intent of this specification is for the DDC system to communicate using the BACnet standard.

This specification is not for use in USACE projects. USACE projects should use Section 23 09 23 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS and Section 25 10 10 LONWORKS UTILITY MONITORING AND CONTROL SYSTEM (UMCS).

The control system will have a BACnet interface for connection to a hand-held device, portable computer, and/or a central workstation computer. Interface computers allow an operator to view operational status, enable and disable equipment, change setpoints, set schedules, receive trends and alarms, and allow storage, modification and downloading of control programming. The operator workstation can be located in the building (directly connected) or at a remote site (connected via a LAN or modem).

If you have questions about the design of direct digital control systems, contact Facilities Engineering Command (FEC) Regional Mechanical Engineer, Naval Facilities Engineering Command Atlantic Mechanical Engineering, or the Naval Facilities Engineering Service Center (NFESC), Code 223.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of Technical Proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

NOTE: This specification requires the new DDC system to support ASHRAE 135 at all device and network levels. If a legacy DDC system is already installed at the building, and costs are too high for replacement, the legacy devices may require a gateway to connect the legacy network/devices to the BACnet architecture. Indicate on the drawings where gateways are required.

NOTE: Avoid using pneumatic powered controls in new DDC systems. In existing systems, replace pneumatic controls with electric/electronic controls when possible.

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside to the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to in the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 500-D (1998) Laboratory Methods of Testing
Dampers for Rating

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/ATA 878.1 (1999) ARCNET - Local Area Network: Token
Ring

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 135 (2008; Addenda J,L,Q,R,S,V 2009; Errata 1
& 2 2009:INT 1 & 2 2009) BACnet-A Data
Communication Protocol for Building
Automation and Control Networks

ASME INTERNATIONAL (ASME)

ASME B16.18 (2001; R 2005) Cast Copper Alloy Solder
Joint Pressure Fittings

ASME B16.22 (2001; R 2005) Standard for Wrought Copper
and Copper Alloy Solder Joint Pressure
Fittings

ASME B16.26 (2006) Standard for Cast Copper Alloy
Fittings for Flared Copper Tubes

ASME B16.34 (2009) Valves - Flanged, Threaded and
Welding End

ASME B16.5 (2009) Standard for Pipe Flanges and
Flanged Fittings: NPS 1/2 Through NPS 24

ASME B31.1 (2007; Addenda a-2008) Power Piping

ASME B40.100 (2005) Pressure Gauges and Gauge
Attachments

ASME BPVC (2007) all Purpose Codes and Standards
Boiler and Pressure Vessels Codes

ASTM INTERNATIONAL (ASTM)

ASTM A 126 (2004) Standard Specification for Gray
Iron Castings for Valves, Flanges, and
Pipe Fittings

ASTM B 117 (2009) Standard Practice for Operating
Salt Spray (Fog) Apparatus

ASTM B 32 (2008) Standard Specification for Solder
Metal

ASTM B 75	(2002) Standard Specification for Seamless Copper Tube
ASTM B 88	(2009) Standard Specification for Seamless Copper Water Tube
ASTM B 88M	(2005) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM D 1238	(2004c) Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D 1693	(2008) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D 635	(2006) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 638	(2008) Standard Test Method for Tensile Properties of Plastics
ASTM D 792	(2008) Density and Specific Gravity (Relative Density) of Plastics by Displacement

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.13	(2008) Standard Requirements for Instrument Transformers
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.45	(2002; R 2008) Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000v and less)AC Power Circuits

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO/IEC 8802-3	(2000) Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD)Access Method and Physical Layer Specifications
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NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA/ANSI C12.10 (2004) Physical Aspects of Watthour Meters
- Safety Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2008; AMD 1 2008) National Electrical Code

NFPA 72 (2010; Am 10-2; Am 10-3; Proposed Am 971)
National Fire Alarm and Signaling Code

NFPA 90A (2009; Errata 09-1) Standard for the
Installation of Air Conditioning and
Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

SMACNA 1966 (2005) HVAC Duct Construction Standards
Metal and Flexible, 3rd Edition

UNDERWRITERS LABORATORIES (UL)

UL 1449 (2006; R 1998 thru 2009) Standard for
Surge Protective Devices

UL 506 (2008; R 2009) Standard for Specialty
Transformers

UL 508A (2001; R 2003 thru 2009) Standard for
Industrial Control Panels

UL 916 (2007; R 2009) Standard for Energy
Management Equipment

1.2 DEFINITIONS

1.2.1 ANSI/ASHRAE Standard 135

ANSI/ASHRAE Standard 135: BACnet - A Data Communication Protocol for Building Automation and Control Networks, referred to as "BACnet". ASHRAE developed BACnet to provide a method for diverse building automation devices to communicate and share data over a network.

1.2.2 ARCNET

ANSI/ATA 878.1 - Attached Resource Computer Network. ARCNET is a deterministic LAN technology; meaning it's possible to determine the maximum delay before a device is able to transmit a message.

1.2.3 BACnet

Building Automation and Control Network; the common name for the communication standard ASHRAE 135. The standard defines methods and protocol for cooperating building automation devices to communicate over a variety of LAN technologies.

1.2.4 BACnet/IP

An extension of BACnet, Annex J, defines this mechanism using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number. See also "BACnet Broadcast Management Device".

1.2.5 BACnet Internetwork

Two or more BACnet networks, possibly using different LAN technologies, connected with routers. In a BACnet internetwork, there exists only one message path between devices.

1.2.6 BACnet Network

One or more BACnet segments that have the same network address and are interconnected by bridges at the physical and data link layers.

1.2.7 BACnet Segment

One or more physical segments of BACnet devices on a BACnet network, connected at the physical layer by repeaters.

1.2.8 BBMD

BACnet Broadcast Management Device (BBMD). A communications device, typically combined with a BACnet router. A BBMD forwards BACnet broadcast messages to BACnet/IP devices and other BBMDs connected to the same BACnet/IP network. Every IP subnetwork that is part of a BACnet/IP network must have only one BBMD. See also "BACnet/IP".

1.2.9 BAS

Building Automation Systems, including DDC (Direct Digital Controls) used for facility automation and energy management.

NOTE: Identify the BAS Owner early in project development. Include the BAS Owner in the project team responsible for design, solicitation, construction, and final acceptance.

1.2.10 BAS Owner

The regional or local user responsible for managing all aspects of the BAS operation, including: network connections, workstation management, submittal review, technical support, control parameters, and daily operation. The BAS Owner for this project is [_____].

1.2.11 BIBBs

BACnet Interoperability Building Blocks. A collection of BACnet services used to describe supported tasks. BIBBs are often described in terms of "A" (client) and "B" (server) devices. The "A" device uses data provided by the "B" device, or requests an action from the "B" device.

1.2.12 BI

BACnet International, formerly two organizations: the BACnet Manufacturers Association (BMA) and the BACnet Interest Group - North America (BIG-NA).

1.2.13 BI/BTL

BACnet International/BACnet Testing Laboratories (Formerly BMA/BTL). The organization responsible for testing products for compliance with the BACnet standard, operated under the direction of BACnet International.

1.2.14 Bridge

Network hardware that connects two or more network (or BACnet internetwork) segments at the physical and data link layers. A bridge may also filter messages.

1.2.15 Broadcast

A message sent to all devices on a network segment.

1.2.16 Device

Any control system component, usually a digital controller, that contains a BACnet Device Object and uses BACnet to communicate with other devices. See also "Digital Controller".

1.2.17 Device Object

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet internetwork. This number is often referred to as the device instance.

1.2.18 Device Profile

A collection of BIBBs determining minimum BACnet capabilities of a device, defined in ASHRAE Standard 135-2004, Annex L. Standard device profiles include BACnet Operator Workstations (B-OWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS). Each device used in new construction is required to have a PICS statement listing BIBBs supported.

1.2.19 Digital Controller

An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions. In most cases, synonymous with a BACnet device described in this specification. See also "Device".

1.2.20 Direct Digital Control (DDC)

Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.

1.2.21 DDC System

A network of digital controllers, communication architecture, and user interfaces. A DDC system may include programming, sensors, actuators, switches, relays, factory controls, operator workstations, and various other devices, components, and attributes.

1.2.22 Ethernet

A family of local-area-network technologies providing high-speed networking features over various media.

1.2.23 Firmware

Software programmed into read only memory (ROM), flash memory, electrically erasable programmable read only memory (EEPROM), or erasable programmable read only memory (EPROM) chips.

1.2.24 Gateway

Communication hardware connecting two or more different protocols, similar to human language translators. The Gateway translates one protocol into equivalent concepts for the other protocol. In BACnet applications, a gateway has BACnet on one side and non-BACnet (usually proprietary) protocols on the other side.

1.2.25 Half Router

A device that participates as one partner in a BACnet point-to-point (PTP) connection. Two half-routers in an active PTP connection combine to form a single router.

1.2.26 Hub

A common connection point for devices on a network.

1.2.27 Internet Protocol (IP, TCP/IP, UDP/IP)

A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

1.2.28 Input/Output (I/O)

Physical inputs and outputs to and from a device, although the term sometimes describes software, or "virtual" I/O. See also "Points".

1.2.29 I/O Expansion Unit

An I/O expansion unit provides additional point capacity to a digital controller.

1.2.30 IP subnet

Internet protocol (IP) identifies individual devices with a 32-bit number

divided into four groups from 0 to 255. Devices are often grouped and share some portion of this number. For example, one device has IP address 209.185.47.68 and another device has IP address 209.185.47.82. These two devices share Class C subnet 209.185.47.00

1.2.31 Local-Area Network (LAN)

A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

1.2.32 LonTalk

ANSI/EIA 709. A communication protocol developed by Echelon Corp. LonTalk is an optional physical and data link layer for BACnet.

1.2.33 MAC Address

Media Access Control address. The physical node address that identifies a device on a Local Area Network.

1.2.34 Master-Slave/Token-Passing (MS/TP)

ISO/IEC 8802-3. One of the LAN options for BACnet. MSTP uses twisted-pair wiring for relatively low speed and low cost communication (up to 4,000 ft at 76.8K bps).

1.2.35 Native BACnet Device

A device that uses BACnet as its primary, if not only, method of communication with other BACnet devices without intermediary gateways. A system that uses native BACnet devices at all levels is a native BACnet system.

1.2.36 Network

Communication technology for data communications. BACnet approved network types are BACnet over Internet Protocol (IP), Point to Point (PTP) Ethernet, ARCNET, MS/TP, and LonTalk®.

1.2.37 Network Number

A site-specific number assigned to each network segment to identify for routing. This network number must be unique throughout the BACnet internetwork.

1.2.38 Object

The concept of organizing BACnet information into standard components with various associated properties. Examples include analog input objects and binary output objects.

1.2.39 Object Identifier

An object property used to identify the object, including object type and instance. Object Identifiers must be unique within a device.

1.2.40 Object Properties

Attributes of an object. Examples include present value and high limit

properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.

1.2.41 Peer-to-Peer

Peer-to-peer refers to devices where any device can initiate and respond to communication with other devices.

1.2.42 Performance Verification Test (PVT)

The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Government.

1.2.43 PID

Proportional, integral, and derivative control; three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

1.2.44 PICS

Protocol Implementation Conformance Statement (PICS), describing the BACnet capabilities of a device. See BACnet, Annex A for the standard format and content of a PICS statement.

1.2.45 Points

Physical and virtual inputs and outputs. See also "Input/Output".

1.2.46 PTP

Point-to-Point protocol connects individual BACnet devices or networks using serial connections like modem-to-modem links.

1.2.47 Repeater

A network component that connects two or more physical segments at the physical layer.

1.2.48 Router

A BACnet router is a component that joins together two or more networks using different LAN technologies. Examples include joining a BACnet Ethernet LAN to a BACnet MS/TP LAN.

1.2.49 Stand-Alone Control

Refers to devices performing equipment-specific and small system control without communication to other devices or computers for physical I/O, excluding outside air and other common shared conditions. Devices are located near controlled equipment, with physical input and output points limited to 64 or less per device, except for complex individual equipment or systems. Failure of any single device will not cause other network devices to fail. BACnet "Smart" actuators (B-SA profile) and sensors (B-SS profile) communicating on a network with a parent device are exempt from stand-alone requirements.

[1.3 SUBCONTRACTOR SPECIAL REQUIREMENTS

NOTE: Delete this paragraph when using this section for a design-build project specification. This requirement is covered by the specifications in NAVFAC Design-Build RFP PART 4, Section D30 HVAC

Perform all work in this section in accordance with the paragraph entitled "Subcontractor Special Requirements" in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS. The paragraph specifies that all contract requirements of this section shall be accomplished directly by a first tier subcontractor. No work required shall be accomplished by a second tier subcontractor.]

1.4 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC DESCRIPTION

NOTE: A thorough investigation of existing systems, hardware, and BAS Owner needs is required before modifying the DDC system description below. You must describe what new DDC equipment goes into the building(s), what are the computer/operator interface requirements, and how the new controls and operator interface will interact with existing infrastructure. System architecture diagrams are very helpful at this point.

- a. [Remove existing and] [provide new BACnet] [and] [modify existing] [and merge with existing non-BACnet] [and merge with existing BACnet] DDC systems including associated equipment and accessories. All new devices are accessible using a Web browser interface and communicate using ASHRAE 135 BACnet communications without the use of gateways, unless gateways are shown on the design drawings and specifically requested by the Government. Where gateways are allowed, they must support ASHRAE 135, including all object properties and read-write services shown on Government approved interoperability schedules. Manufacturer's products, including design, materials, fabrication, assembly, inspection, and testing shall be in accordance with ASHRAE 135, ASME B31.1, and NFPA 70, except where indicated otherwise.

NOTE: The next paragraph provides more specific information when merging or adding a new to existing BACnet system.

- [b. The existing DDC system is manufactured by [_____]. The server and operator workstation are located at [_____]. If installing a system made by the same manufacturer, upgrade or replace the existing server, operator workstation, and laptop computer software with the manufacturer's latest software version for all used applications. Upgrade hardware, memory, and operating systems if required.]

1.4.1 Design Requirements

1.4.1.1 Control System Drawings Title Sheet

Provide a title sheet for the control system drawing set. Include the project title, project location, contract number, the controls contractor preparing the drawings, an index of the control drawings in the set, and a legend of the symbols and abbreviations used throughout the control system drawings.

1.4.1.2 List of I/O Points

Also known as a Point Schedule, provide for each input and output point physically connected to a digital controller: point name, point description, point type (Analog Output (AO), Analog Input (AI), Binary Output (BO), Binary Input (BI)), point sensor range, point actuator range, point address, BACnet object, associated BIBBS (where applicable), and point connection terminal number. Typical schedules for multiple identical equipment are allowed unless otherwise requested in design or contract criteria.

1.4.1.3 Control System Components List

Provide a complete list of control system components installed on this project. Include for each controller and device: control system schematic name, control system schematic designation, device description, manufacturer, and manufacturer part number. For sensors, include point name, sensor range, and operating limits. For valves, include body style, Cv, design flow rate, pressure drop, valve characteristic (linear or equal percentage), and pipe connection size. For actuators, include point name, spring or non-spring return, modulating or two-position action, normal (power fail) position, nominal control signal operating range (0-10 volts DC or 4-20 milliamps), and operating limits.

1.4.1.4 Control System Schematics

Provide control system schematics. Typical schematics for multiple identical equipment are allowed unless otherwise requested in design or contract criteria. Include the following:

- a. Location of each input and output device
- b. Flow diagram for each piece of HVAC equipment
- c. Name or symbol for each control system component, such as V-1 for a valve
- d. Setpoints, with differential or proportional band values
- e. Written sequence of operation for the HVAC equipment
- f. Valve and Damper Schedules, with normal (power fail) position

1.4.1.5 HVAC Equipment Electrical Ladder Diagrams

Provide HVAC equipment electrical ladder diagrams. Indicate required electrical interlocks.

1.4.1.6 Component Wiring Diagrams

Provide a wiring diagram for each type of input device and output device. Indicate how each device is wired and powered; showing typical connections at the digital controller and power supply. Show for all field connected devices such as control relays, motor starters, actuators, sensors, and transmitters.

1.4.1.7 Terminal Strip Diagrams

Provide a diagram of each terminal strip. Indicate the terminal strip location, termination numbers, and associated point names.

1.4.1.8 BACnet Communication Architecture Schematic

Provide a schematic showing the project's entire BACnet communication network, including addressing used for LANs, LAN devices including routers and bridges, gateways, controllers, workstations, and field interface devices. If applicable, show connection to existing networks.

1.5 SUBMITTALS

Submit detailed and annotated manufacturer's data, drawings, and specification sheets for each item listed, that clearly show compliance with the project specifications.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following according to 01 33 00 SUBMITTAL PROCEDURES:

**NOTE: The BAS Owner will be the primary reviewer
 for submittals marked by the "G". Delete items if
 not used in the control system.**

SD-02 Shop Drawings

Include the following in the project's control system drawing set:

Control system drawings title sheet; G

List of I/O Points; G

Control System Components List; G

Control system schematics; G

HVAC Equipment Electrical Ladder diagrams; G

Component wiring diagrams; G

Terminal strip diagrams; G

BACnet communication architecture schematic; G

SD-03 Product Data

Direct Digital Controllers; G

Include BACnet PICS for each controller/device type, including smart sensors (B-SS) and smart actuators (B-SA).

BACnet Gateways; G

Include BACnet and workstation display information; bi-directional communication ability; compliance with interoperability schedule; expansion capacity; handling of alarms, events, scheduling and trend data; and single device capability (not depending on multiple devices for exchanging information from either side of the gateway).

BACnet Protocol Analyzer; G

Include capability to store and report data traffic on BACnet networks, measure bandwidth usage, filter information, and identify BACnet devices.

DDC Software; G

BACnet Operator Workstation; G

BACnet Operator Workstation DDC Software; G

Include BACnet PICS for Operator Workstation software.

Notebook Computer; G

Sensors and Input Hardware; G

Output Hardware; G

Surge and transient protection; G

Indicators; G

[Air compressors; G]

[Refrigerated air dryers; G]

[Pneumatic tubing; G]

NOTE: Delete this item if smoke detectors are
furnished under Section UFGS 28 31 74.00 20 INTERIOR
FIRE DETECTION AND ALARM SYSTEM.

[Duct smoke detectors; G]

NOTE: Delete this item if VFDs are furnished under
another section.

[Variable frequency (motor) drives; G]

SD-05 Design Data

Performance Verification Testing Plan; G

Pre-Performance Verification Testing Checklist; G

SD-06 Test Reports

Performance Verification Testing Report; G

SD-07 Certificates

Contractor's Qualifications; G

SD-09 Manufacturer's Field Reports

Pre-PVT Checklist; G

SD-10 Operation and Maintenance Data

Comply with requirements for data packages in Section 01 78 23 OPERATION AND MAINTENANCE DATA, except as supplemented and modified in this specification.

BACnet Direct Digital Control Systems, Data Package 4; G

Controls System Operators Manuals, Data Package 4; G

VFD Service Manuals, Data Package 4; G

SD-11 Closeout Submittals

Training documentation; G

1.6 QUALITY ASSURANCE

1.6.1 Standard Products

Provide material and equipment that are standard manufacturer's products currently in production and supported by a local service organization.

1.6.2 Delivery, Storage, and Handling

Handle, store, and protect equipment and materials to prevent damage before and during installation according to manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6.3 Operating Environment

Protect components from humidity and temperature variation, dust, and contaminants. If components are stored before installation, keep them within the manufacturer's limits.

1.6.4 Finish of New Equipment

New equipment finishing shall be factory provided. Manufacturer's standard factory finishing shall be proven to withstand 125 hours in a salt-spray fog test. Equipment located outdoors shall be proven to withstand 500 hours in a salt-spray fog test.

Salt-spray fog test shall be according to ASTM B 117, with acceptance

criteria as follows: immediately after completion of the test, the finish shall show no signs of degradation or loss of adhesion beyond 3.175 mm 0.125 inch on either side of the scratch mark.

1.6.5 Verification of Dimensions

The contractor shall verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing work.

1.6.6 Contractor's Qualifications

Submit documentation certifying the controls Contractor performing the work has completed at least three DDC systems installations of a similar design to this project, and programmed similar sequences of operation for at least two years.

1.6.7 Modification of References

The advisory provisions in ASME B31.1 and NFPA 70 are mandatory. Substitute "shall" for "should" wherever it appears and interpret all references to the "authority having jurisdiction" and "owner" to mean the Contracting Officer.

1.6.8 Project Sequence

The control system work for this project shall proceed in the following order:

- a. Submit and receive approval on the Shop Drawings, Product Data, and Certificates specified under the paragraph entitled "SUBMITTALS."
- b. Perform the control system installation work, including all field check-outs and tuning.
- c. Provide support to TAB personnel as specified under the paragraph "TEST AND BALANCE SUPPORT."
- d. Submit and receive approval of the Controls System Operators Manual specified under the paragraph "CONTROLS SYSTEM OPERATORS MANUALS."
- e. Submit and receive approval of the Performance Verification Testing Plan and the Pre-PVT Checklist specified under the paragraph "PERFORMANCE VERIFICATION TESTING."
- f. Perform the Performance Verification Testing.
- g. Submit and receive approval on the PVT Report.
- h. Submit and receive approval on the Training Documentation specified under the paragraph "INSTRUCTION TO GOVERNMENT PERSONNEL"[and "VFD Service Support"]. Submit at least 30 days before training.
- i. Deliver the final Controls System Operators Manuals[and VFD Service Manuals].
- j. Conduct the Phase I Training[and VFD on-site/hands-on training].
- k. Conduct the Phase II Training.

1. Submit and receive approval of Closeout Submittals.

PART 2 PRODUCTS

2.1 DDC SYSTEM

NOTE: Consider below whether to require integral, or factory-provided ("Native") BACnet controllers for HVAC and plant equipment. If so, coordinate this requirement with other sections and specifications for plant equipment. This allows eliminating redundant sensor/actuator requirements and provides access to many control and status parameters using BACnet with a single LAN connection to the equipment. Possible disadvantages include higher cost, disqualifying otherwise qualified vendors, and more detailed integration criteria.

NOTE: Using only BTL listed devices (last sentence in brackets paragraph 2.1.a) requires investigation. Devices listed by the BACnet Testing Labs will provide a higher level of assurance that they meet claimed performance. However, requiring BTL listed products may eliminate otherwise qualified vendors, or those in line for testing but not yet certified. To help determine whether this requirement should be used, a current list of BTL certified devices are published at:
<http://www.bacnetassociation.org/btl/>.

- a. Provide a networked DDC system for stand-alone control in compliance with the latest revision of the **ASHRAE 135** BACnet standard. Include all programming, objects, and services required to meet the sequence of control. Provide BACnet communications between the DDC system and native BACnet devices furnished with HVAC equipment [and plant equipment including boilers, chillers, and variable frequency drives]. [Devices provided shall be certified in the BACnet Testing Laboratories (BTL) Product Listing.]

NOTE: Always indicate the location of operator workstations and servers on project drawings. Edit and coordinate the below paragraph with Section 1, DDC System Description and the BAS Owner.

- [b. Provide an operator workstation [and new server] with complete interface software capable of programming, configuring, and monitoring the digital controllers.][Interface the new DDC system with the site's existing server and operator workstation and software including graphic creation, scheduling, alarming, and trending. The server and workstation are located at [_____]]

2.1.1 Direct Digital Controllers

Direct digital controllers shall be UL 916 rated.

2.1.1.1 I/O Point Limitation

The total number of I/O hardware points used by a single stand-alone digital controller, including I/O expansion units, shall not exceed 64, except for complex individual equipment or systems. Place I/O expansion units in the same cabinet as the digital controller.

2.1.1.2 Environmental Limits

Controllers shall be suitable for, or placed in protective enclosures suitable for the environment (temperature, humidity, dust, and vibration) where they are located.

2.1.1.3 Stand-Alone Control

Provide stand-alone digital controllers.

2.1.1.4 Internal Clock

Provide internal clocks for all BACnet Building Controllers (B-BC) and BACnet Advanced Application Controllers (B-AAC) using BACnet time synchronization services. Automatically synchronize system clocks daily from an operator-designated controller. The system shall automatically adjust for daylight saving time.

2.1.1.5 Memory

Provide sufficient memory for each controller to support the required control, communication, trends, alarms, and messages. Protect programs residing in memory with EEPROM, flash memory, or by an uninterruptible power source (battery or uninterruptible power supply). The backup power source shall have capacity to maintain the memory during a 72-hour continuous power outage. Rechargeable power sources shall be constantly charged while the controller is operating under normal line power. Batteries shall be replaceable without soldering. Trend and alarm history collected during normal operation shall not be lost during power outages less than 72 hours long.

2.1.1.6 Immunity to Power Fluctuations

Controllers shall operate at 90 percent to 110 percent nominal voltage rating.

2.1.1.7 Transformer

The controller power supply shall be fused or current limiting and rated at 125 percent power consumption.

2.1.1.8 Wiring Terminations

Use screw terminal wiring terminations for all field-installed controllers. Provide field-removable modular terminal strip or a termination card connected by a ribbon cable for all controllers other than terminal units.

2.1.1.9 Input and Output Interface

Provide hard-wired input and output interface for all controllers as follows:

- a. Protection: Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with sources up to 24 volts AC or DC for any duration shall cause no controller damage.
- b. Binary Inputs: Binary inputs shall have a toggle switch and monitor on and off contacts from a "dry" remote device without external power, and external 5-24 VDC voltage inputs.
- c. Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and accumulate pulses at a resolution suitable to the application.
- d. Analog Inputs: Analog inputs shall monitor low-voltage (0-10 VDC), current (4-20 mA), or resistance (thermistor or RTD) signals.
- e. Binary Outputs: Binary outputs shall have a toggle switch and send a pulsed 24 VDC low-voltage signal for modulation control, or provide a maintained open-closed position for on-off control. For HVAC equipment and plant controllers, provide for manual overrides, either with three-position (on-off-auto) override switches and status lights, or with an adjacent operator display and interface. Where appropriate, provide a method to select normally open or normally closed operation.
- f. Analog Outputs: Analog outputs shall send modulating 0-10 VDC or 4-20 mA signals to control output devices.
- g. Tri-State Outputs: Tri-State outputs shall provide three-point floating control of terminal unit electronic actuators.

2.1.1.10 Digital Controller BACnet Internetwork

Provide a BACnet internetwork with control products, communication media, connectors, repeaters, hubs, and routers. Provide intermediate gateways, only when requested by the Government and shown on the contract drawings, to connect existing non-BACnet devices to the BACnet internetwork. Controller and operator interface communication shall conform to [ASHRAE 135](#), BACnet. [Use the building's existing Ethernet backbone for network segments marked "existing" on project drawings. Coordinate connections to existing Ethernet backbones with the BAS Owner and LAN administrator.] If a controller becomes non-responsive, the remaining controllers shall continue operating and not be affected by the failed controller.

2.1.1.11 Communications Ports

- a. Direct-Connect Interface Ports: Provide at least one extra communication port at each local BACnet network for direct connecting a notebook computer or BACnet hand-held terminal so all network BACnet objects and properties may be viewed and edited by the operator.
- b. Telecommunications Interface Port: Provide one telecommunication port

per building, permitting remote communication via point-to-point (PTP) protocol over telephone lines.

2.1.1.12 Modems

Provide [v.92] [DSL] modems where required for communication between the BACnet Operator Workstation (B-OWS) and the DDC system.

2.1.1.13 BACnet Gateways

NOTE: Gateways require a good understanding of when and where to use them. Use Caution when trying to connect to non-BACnet DDC and OEM equipment. It may be more practical to select new equipment that is already "BACnet ready". Research gateway manufacturers for price, options, and performance before including in the design.

When using gateways, they must be requested and approved by the Government and specifically shown on BACnet communication schematic architecture drawings.

For each gateway, the design needs to include an interoperability schedule showing each point or event on the legacy side that the BACnet "client" will read, and each parameter that the BACnet network will write to. Ideally, one should do this in terms of BACnet services, or BACnet Interoperability Building Blocks (BIBBs) defined in ASHRAE 135 Annex K.

Provide BACnet communication ports, whenever available as a plant equipment OEM standard option, for DDC integration via a single communication cable. Typical BACnet controlled plant equipment includes, but is not limited to, boilers, chillers, and variable frequency motor drives.

Provide gateways to connect BACnet to legacy systems, existing non-BACnet devices, and existing non-BACnet DDC controlled plant equipment, only when specifically requested and approved by the Government, and shown on the Government approved BACnet Communication Architecture Schematic. Provide with each gateway an interoperability schedule [Use gateway interoperability schedules shown on design drawings or other project documents], showing each point or event on the legacy side that the BACnet "client" will read, and each parameter that the BACnet network will write to. Describe this interoperability in terms of BACnet services, or Interoperability Building Blocks (BIBBs), defined in ASHRAE 135 Annex K. Provide two-year minimum warranty for each gateway, including parts and labor.

The following minimum capabilities are required:

- a. Gateways shall be able to read and view all readable object properties listed in the interoperability schedule on the non-BACnet network to the BACnet network and vice versa where applicable.
- b. Gateways shall be able to write to all writeable object properties listed in the interoperability schedule on the non-BACnet network from

the BACnet network and vice versa where applicable.

- c. Gateways shall provide single-pass (only one protocol to BACnet without intermediary protocols) translation from the non-BACnet protocol to BACnet and vice versa.
- d. Gateways shall meet the requirements of Data Sharing Read Property (DS-RP-B), Data Sharing Write Property (DS-WP-B), Device Management Dynamic Device Binding-B (DM-DDB-B), and Device Management Communication Control (DM-DCC-B) BIBBs, in accordance with [ASHRAE 135](#).
- e. Gateways shall include all hardware, software, software licenses, and configuration tools for operator-to-gateway communications. Provide backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

2.1.1.14 Digital Controller Cabinet

NOTE: Indicate control devices that must be in enclosures with more stringent requirements than NEMA 1 or NEMA 4.

Provide each digital controller in a factory fabricated cabinet enclosure. Cabinets located indoors shall protect against dust and have a minimum NEMA 1 rating, except where indicated otherwise. Cabinets located outdoors or in damp environments shall protect against all outdoor conditions and have a minimum NEMA 4 rating. Outdoor control panels and controllers must be able to withstand extreme ambient conditions, without malfunction or failure, whether or not the controlled equipment is running. If necessary, provide a thermostatically controlled panel heater in freezing locations, and an internal ventilating fan in locations exposed to direct sunlight. Cabinets shall have a hinged lockable door and an offset removable metal back plate, except controllers integral with terminal units, like those mounted on VAV boxes. Provide like-keyed locks for all hinged panels provided and a set of two keys at each panel, with one key inserted in the lock.

2.1.1.15 Main Power Switch and Receptacle

Provide each control cabinet with a main external power on/off switch located inside the cabinet. Also provide each cabinet with a separate 120 VAC duplex receptacle.

2.1.2 DDC Software

NOTE: Provide a complete, clear, and concise written sequence of operation for the HVAC equipment. Include all conventional control operations, time event operations, energy management functions (night setback, reset schedules, optimum start), push button overrides, demand limiting, safeties, and emergency conditions. Put the sequence of operation on the design drawings, not in the specifications.

2.1.2.1 Programming

NOTE: Graphic-based programming is available from many vendors and is preferred to line-by-line programming because it is easier to document, learn and troubleshoot.

Many manufacturers use menu-based programming that is also easy to learn, but may not document the sequences visually, and is arguably not as flexible as graphic programming..

Text-based or line-by-line programming is flexible, but difficult to standardize and troubleshoot. It requires more time to learn, and is sometimes difficult to follow what others have written.

Provide programming to execute the sequence of operation indicated. Provide all programming and tools to configure and program all controllers. Provide programming routines in simple, easy-to-follow logic with detailed text comments describing what the logic does and how it corresponds to the project's written sequence of operation.

- a. Graphic-based programming shall use a library of function blocks made from pre-programmed code designed for BAS control. Function blocks shall be assembled with interconnecting lines, depicting the control sequence in a flowchart. If providing a computer with device programming tools as part of the project, graphic programs shall be viewable in real time showing present values and logical results from each function block.
- b. Menu-based programming shall be done by entering parameters, definitions, conditions, requirements, and constraints.
- c. For line-by-line and text-based programming, declare variable types (local, global, real, integer, etc.) at the beginning of the program. Use descriptive comments frequently to describe the programming.
- d. If providing a computer with device programming tools as part of the project, provide a means for detecting program errors and testing software strategies with a simulation tool. Simulation may be inherent within the programming software suite, or provided by physical controllers mounted in a NEMA 1 test enclosure. The test enclosure shall contain one dedicated controller of each type provided under this contract, complete with power supply and relevant accessories.

2.1.2.2 Parameter Modification

All writeable object properties, and all other programming parameters needed to comply with the project specification shall be adjustable for devices at any network level, including those accessible with web-browser communication, and regardless of programming methods used to create the applications.

2.1.2.3 Short Cycling Prevention

Provide setpoint differentials and minimum on/off times to prevent equipment short cycling.

2.1.2.4 Equipment Status Delay

Provide an adjustable delay from when equipment is commanded on or off and when the control program looks to the status input for confirmation.

2.1.2.5 Run Time Accumulation

Use the Elapsed Time Property to provide re-settable run time accumulation for each Binary Output Object connected to mechanical loads greater than 1 HP, electrical loads greater than 10 KW, or wherever else specified.

2.1.2.6 Timed Local Override

Provide an adjustable override time for each push of a timed local override button.

2.1.2.7 Time Synchronization

Provide time synchronization, including adjustments for leap years, daylight saving time, and operator time adjustments.

2.1.2.8 Scheduling

Provide operating schedules as indicated, with equipment assigned to groups. Changing the schedule of a group shall change the operating schedule of all equipment in the group. Groups shall be capable of operator creation, modification, and deletion. Provide capability to view and modify schedules in a seven-day week format. Provide capability to enter holiday and override schedules one full year at a time.

2.1.2.9 Object Property Override

Allow writeable object property values to accept overrides to any valid value. Where specified or required for the sequence of control, the Out_Of_Service property of Objects shall be modifiable using BACnet's write property service. When documented, exceptions to these requirement are allowed for life, machine, and process safeties.

2.1.2.10 Alarms and Events

Alarms and events shall be capable of having programmed time delays and high-low limits. When a computer workstation or web server is connected to the BACnet internetwork, alarms/events shall report to the computer, printer, [alphanumeric pager,] [e-mail,] [cell phone,] as defined by an authorized operator. Otherwise alarms/events shall be stored within a device on the BACnet network until connected to a user interface device and retrieved. Provide alarms/events in agreement with the point schedule, sequence of operation, and the BAS Owner. At a minimum, provide programming to initiate alarms/events any time a piece of equipment fails to operate, a control point is outside normal range or condition shown on schedules, communication to a device is lost, a device has failed, or a controller has lost its memory.

2.1.2.11 Trending

Provide BACnet trend services capable of trending all object present values set points, and other parameters indicated for trending on project schedules. Trends may be associated into groups, and a trend report may be

set up for each group. Trends are stored within a device on the BACnet network, with operator selectable trend intervals from 10 seconds up to 60 minutes. The minimum number of consecutive trend values stored at one time shall be 100 per variable. When trend memory is full, the most recent data shall overwrite the oldest data.

The operator workstation shall upload trends automatically upon reaching 3/4 of the device buffer limit (via Notification_Threshold property), by operator request, or by time schedule for archiving. Archived and real-time trend data shall be available for viewing numerically and graphically for at the workstation and connected notebook computers.

2.1.2.12 Device Diagnostics

Each controller shall have diagnostic LEDs for power, communication, and device fault condition. The DDC system shall recognize and report a non-responsive controller.

2.1.2.13 Power Loss

Upon restoration of power, the DDC system shall perform an orderly restart and restoration of control.

2.1.3 BACnet Operator Workstation

**NOTE: Delete this paragraph and subparagraphs below
when a new operator workstation is not required.**

The workstation shall be capable of accessing all DDC system devices and communicate using the BACnet protocol. The workstation shall be capable of displaying, modifying, creating, archiving, and deleting (as applicable): all points, objects, object properties, programming, alarms, trends, messages, schedules, and reports.

2.1.3.1 BACnet Operator Workstation Hardware

**NOTE: Update computer criteria as technology
dictates.**

Configure according to system manufacturer's specifications and conforming to BACnet Operator Workstation (B-OWS) device standards found in [ASHRAE 135](#), Annex L. Install to permit complete monitoring and troubleshooting of the DDC system.

At a minimum the workstation hardware shall include: a desktop personal computer with Microsoft Windows XP or VISTA Professional operating system or equal, processor and RAM exceeding capability and speed required by operating system and application software, hard drive capacity exceeding software and yearly archive requirements, 16X internal DVD+/-R/RW/CD-RW drive with archive creator software, [external 200 GB USB 2.0 hard drive and cable,] 4 USB 2.0 ports, 10/100 network interface card, [MS/TP card,] 19-inch LCD monitor, internal V.92 modem, sound card with speakers, 101 character keyboard, optical mouse, USB Hub with four USB 2.0 ports and connecting cable, [ink jet] [laser] printer with USB port and cable, [3 matching toner cartridges] [3 matching color and black ink cartridges], 120-volt 800 VA uninterruptible power supply with automatic voltage regulation and 4 minimum battery back-up outlets and 2 surge protected

outlets, [[Microsoft Office bundled software,] [Adobe Acrobat Writer,] [and Symantec Ghost disk imaging software or equal]]. Provide all original licenses, installation media, documentation, and recovery CDs capable of restoring the original configuration. Provide a manufacturer's 3-year next business day on-site warranty with the Government listed as the warranty owner.

2.1.1.3.2 Password Protection

Provide at least five levels of password protection for operator interfaces. The lowest level only allow viewing graphics. The second level allows viewing graphics and changing space temperature setpoints. The third level allows the previous level's capability, plus changing operating schedules. The fourth level allows access to all functions except passwords. The highest level provides all administrator rights and allows full access to all programming, including setting new passwords and access levels. Provide the BAS Owner with the highest level password access. Provide automatic log out if no keyboard or mouse activity is detected after a user-defined time delay.

2.1.1.3.3 BACnet Operator Workstation DDC Software

Provide the workstation software with the manufacturer's installation CDs and licenses. Configure the software according to the DDC system manufacturer's specifications and in agreement with BACnet Operator Workstation (B-OWS) device standards found in [ASHRAE 135](#), Annex L.

The workstation software shall permit complete monitoring, modification, and troubleshooting interface with the DDC system. The operator interface with the software shall be menu-driven with appropriate displays and menu commands to manipulate the DDC system's objects, point data, operating schedules, control routines, system configuration, trends, alarms, messages, graphics, and reports. Trends shall be capable of graphic display in real time, with variables plotted as functions of time. Each alarmed point shall be capable of displaying its alarm history, showing when it went into alarm, if and when it was acknowledged, and when it went out of alarm. The modification of DDC system parameters and object properties shall be accomplished with "fill in the blank" and/or "point and drag" methods. Modifications shall download to the appropriate controllers at the operator's request.

2.1.1.3.4 Graphics Software

Provide web-based system graphics viewable on browsers compatible with MS Internet Explorer 6.X or greater using an industry-standard file format such as HTML, BMP, JPEG, or GIF.

Graphic displays shall have full-screen resolution when viewed on the workstation and notebook computers. Dynamic data on graphics pages shall refresh within 10 seconds using an Internet connection, or 30 seconds using a dial-up modem connection. Graphics viewing shall not require additional "plug-in" software like Java, Shockwave and Flash applications unless the software is readily available for free over the Internet, and certified for use with Navy Marine Corps Internet (NMCI) personal computers.

The graphics shall show the present value and object name for each of the project's I/O points on at least one graphic page. Arrange point values and names on the graphic displays in their appropriate physical locations with respect to the floor plan or equipment graphic displayed. Graphics

shall allow the operator to monitor current status, view zone and equipment summaries, use point-and-click navigation between graphic pages, and edit setpoints and parameters directly from the screens. Items in alarm shall be displayed using a different color or other obvious visual indicator. Provide graphics with the following:

- a. **Graphic Types:** Provide at least one graphic display for each piece of HVAC equipment, building floor, and controlled zone. Indicate dynamic point values, operating statuses, alarm conditions, and control setpoints on each display. Provide summary pages where appropriate.

- (1) **Building Elevation:** For buildings more than one story, provide an elevation view of the building with links to each of the building's floor plans. Simulate the building's architecture and include the building number and floor numbers. If possible, use an actual photograph of the building.
- (2) **Building Floor Plans:** Provide a floor plan graphic for each of the building's floors [and roof] with dynamic display of space temperature and other important data. If used, indicate and provide links to sub-plan areas. If possible, use the project's electronic drawing files for the graphic backgrounds. Provide clear names for important areas, such as "Main Conference Room." Include room names and numbers where applicable. Include features such as stairwells, elevators, and main entrances. Where applicable, include the mechanical room, HVAC equipment, and control component locations, with corresponding links to the equipment graphics.
- (3) **Sub-plan Areas:** Where a building's floor plan is too large to adequately display on the screen, sub-divide the plan into distinct areas, and provide a separate graphic display for each area. Provide same level of detail requested in building floor plan section above.
- (4) **HVAC Equipment:** Provide a graphic display for each piece of HVAC equipment, such as a fan coil unit, VAV terminal, or air handling unit. Equipment shall be represented by a two or three-dimensional drawing. Where multiple pieces of equipment combine to form a system, such as a central chiller plant or central heating plant, provide one graphic to depict the entire plant. Indicate the equipment, piping, ductwork, dampers, and control valves in the installed location. Include labels for equipment, piping, ductwork, dampers, and control valves. Show the direction of air and water flow. Include dynamic display of applicable object data with clear names in appropriate locations.
- (5) **Sequence of Operation:** Provide a graphic screen displaying the written out full sequence of operation for each piece of HVAC equipment. Provide a link to the sequence of operation displays on their respective equipment graphics.[Include dynamic real-time data within the text for setpoints and variables.]

- b. **Graphic Title:** Provide a prominent, descriptive title on each graphic page.
- c. **Dynamic Update:** When the workstation is on-line, all graphic I/O object values shall update with change-of-value services, or by operator selected discrete intervals.

- d. Graphic Linking: Provide forward and backward linking between floor plans, sub-plans, and equipment.
- e. Graphic Editing: Provide installed software to create, modify, and delete the DDC graphics. Include the ability to store graphic symbols in a symbol directory and import these symbols into the graphics.
- f. Dynamic Point Editing: Provide full editing capability for deleting, adding, and modifying dynamic points on the graphics.

2.1.4 Notebook Computer

Provide a notebook computer, complete with the project's installed DDC software, applications database, and graphics to fully troubleshoot and program the project's devices. Notebook computers for web-based systems do not require this installed software if they have the ability to connect locally in real time, view all graphics, and fully troubleshoot, modify, and program all project devices. Provide the notebook computer with ballistic nylon carrying case with shoulder strap [on wheels with a telescoping handle]with all necessary cables and interface hardware needed for setup and communication with the controllers and control system components.

At a minimum the notebook computer shall include: a Microsoft XP Professional operating system, processor with capability and speed required by application software, 40 giga-byte hard drive, 512 mega-byte RAM, 2 USB 2.0 ports, 10/100 network interface card,[ARCnet card,] [MS/TP card,] internal V.92 modem, 15-inch display, keyboard, 3-hour battery with charger, 52X internal CD-RW drive with CD creator software, [and Microsoft Office bundled software]. Provide all original licenses, installation media, documentation, and recovery CDs capable of restoring the original configuration. Provide the manufacturer's 3-year next business day on-site warranty with the Government listed as the warranty owner.

NOTE: The BACnet Protocol Analyzer is typically software for connecting a computer to any BACnet network and sweeping it for basic system information. It is very useful for integration projects with poorly documented systems, or where different BACnet manufacturers reside on the same network.

It takes a moderate level of skill and knowledge to use and understand a Protocol Analyzer. Delete the requirement below if local users already have it, or if they are not interested in using it.

2.1.5 BACnet Protocol Analyzer

Provide a BACnet protocol analyzer and required cables and fittings for connection to the BACnet network. The analyzer shall include the following minimum capabilities:

- a. Capture and store to a file data traffic on all network levels.
- b. Measure bandwidth usage.

- c. Filtering options with ability to ignore select traffic.

2.2 SENSORS AND INPUT HARDWARE

Coordinate sensor types with the BAS Owner to keep them consistent with existing installations.

2.2.1 Field-Installed Temperature Sensors

Where feasible, provide the same sensor type throughout the project. Avoid using transmitters unless absolutely necessary.

2.2.1.1 Thermistors

Precision thermistors may be used in applications below 200 degrees F. Sensor accuracy over the application range shall be 0.36 degree F or less between 32 to 150 degrees F. Stability error of the thermistor over five years shall not exceed 0.25 degrees F cumulative. A/D conversion resolution error shall be kept to 0.1 degrees F. Total error for a thermistor circuit shall not exceed 0.5 degrees F.

2.2.1.2 Resistance Temperature Detectors (RTDs)

Provide RTD sensors with platinum elements compatible with the digital controllers. Encapsulate sensors in epoxy, series 300 stainless steel, anodized aluminum, or copper. Temperature sensor accuracy shall be 0.1 percent (1 ohm) of expected ohms (1000 ohms) at 32 degrees F. Temperature sensor stability error over five years shall not exceed 0.25 degrees F cumulative. Direct connection of RTDs to digital controllers without transmitters is preferred. When RTDs are connected directly, lead resistance error shall be less than 0.25 degrees F. The total error for a RTD circuit shall not exceed 0.5 degrees F.

2.2.1.3 Temperature Sensor Details

**NOTE: Where feasible, include a supply air
temperature sensor for all air handling, fan coil,
and VAV terminal units for troubleshooting and
performance monitoring.**

- a. Room Type: Provide the sensing element components within a decorative protective cover suitable for surrounding decor. [Provide room temperature sensors with timed override button, setpoint adjustment lever, digital temperature display.] [Provide a communication port or 802.11x wireless support for a portable operator interface like a notebook computer or PDA.]
- b. Duct Probe Type: Ensure the probe is long enough to properly sense the air stream temperature.
- c. Duct Averaging Type: Continuous averaging sensors shall be one foot in length for each 4 square feet of duct cross-sectional area, and a minimum length of 6 feet.
- d. Pipe Immersion Type: Provide minimum three-inch immersion. Provide each sensor with a corresponding pipe-mounted sensor well, unless

indicated otherwise. Sensor wells shall be stainless steel when used in steel piping, and brass when used in copper piping. Provide the sensor well with a heat-sensitive transfer agent between the sensor and the well interior.

- e. Outside Air Type: Provide the sensing element on the building's north side with a protective weather shade that positions the sensor approximately 3 inches off the wall surface, does not inhibit free air flow across the sensing element, and protects the sensor from snow, ice, and rain.

2.2.2 Transmitters

Provide transmitters with 4 to 20 mA or 0 to 10 VDC linear output scaled to the sensed input. Transmitters shall be matched to the respective sensor, factory calibrated, and sealed. Size transmitters for an output near 50 percent of its full-scale range at normal operating conditions. The total transmitter error shall not exceed 0.1 percent at any point across the measured span. Supply voltage shall be 12 to 24 volts AC or DC. Transmitters shall have non-interactive offset and span adjustments. For temperature sensing, transmitter drift shall not exceed 0.03 degrees F a year.

2.2.2.1 Relative Humidity Transmitters

NOTE: Even on projects without direct humidity control, include room RH sensors in important areas for monitoring at the workstation.

Provide transmitters with an accuracy equal to plus or minus 3 [2] [5] percent from 0 to 90 percent scale, and less than one percent drift per year. Sensing elements shall be the polymer type.

2.2.2.2 Pressure Transmitters

Provide transmitters integral with the pressure transducer.

2.2.3 Current Transducers

Provide current transducers to monitor motor amperage, unless current switches are shown on design drawings or point tables.

2.2.4 Pneumatic to Electric Transducers

Pneumatic to electronic transducers shall convert a 0 to 20 psig signal to a proportional 4 to 20 mA or 0 to 10 VDC signal (operator scaleable). Supply voltage shall be 24 VDC. Accuracy and linearity shall be 1.0 percent or better.

2.2.5 Air Quality Sensors

NOTE: Choose between CO2 sensors and air quality sensors, or use both. CO2 sensors provide information to ensure adequate ventilation. Air quality sensors are useful to monitor areas

**vulnerable to organic contaminants like car exhaust
and industrial solvents.**

Provide power supply for each sensor.

2.2.5.1 CO2 Sensors

Provide photo-acoustic type CO2 sensors with integral transducers and linear output. The devices shall read CO2 concentrations between 0 and 2000 ppm with full scale accuracy of at least plus or minus 100 ppm.

2.2.5.2 Air Quality Sensors

Provide full spectrum air quality sensors using a hot wire element based on the Taguchi principle. The sensor shall monitor a wide range of gaseous volatile organic components common in indoor air contaminants like paint fumes, solvents, cigarette smoke, and vehicle exhaust. The sensor shall automatically compensate for temperature and humidity, have span and calibration potentiometers, operate on 24 VDC power with output of 0-10 VDC, and have a service rating of 32 to 140 degrees F and 5 to 95 percent relative humidity.

2.2.6 Input Switches

2.2.6.1 Timed Local Overrides

Provide buttons or switches to override the DDC occupancy schedule programming for each major building zone during unoccupied periods, and to return HVAC equipment to the occupied mode. This requirement is waived for zones clearly intended for 24 hour continuous operation.

2.2.7 Freeze Protection Thermostats

Provide special purpose thermostats with flexible capillary elements 20 feet minimum length for coil face areas up to 40 square feet. Provide longer elements for larger coils at 1-foot of element for every 4 square feet of coil face area, or provide additional thermostats. Provide switch contacts rated for the respective motor starter's control circuit voltage. Include auxiliary contacts for the switch's status condition. A freezing condition at any 18-inch increment along the sensing element's length shall activate the switch. The thermostat shall be equipped with a manual push-button reset switch so that when tripped, the thermostat requires manual resetting before the HVAC equipment can restart.

2.2.8 Air Flow Measurement Stations

Air flow measurement stations shall have an array of velocity sensing elements and straightening vanes inside a flanged sheet metal casing. The velocity sensing elements shall be the RTD or thermistor type, traversing the ducted air in at least two directions. The air flow pressure drop across the station shall not exceed 0.08 inch water gage at a velocity of 2,000 fpm. The station shall be suitable for air flows up to 5,000 fpm, and a temperature range of 40 to 120 degrees F. The station's measurement accuracy over the range of 125 to 2,500 fpm shall be plus or minus 3 percent of the measured velocity. Station transmitters shall provide a linear, temperature-compensated 4 to 20 mA or 0 to 10 VDC output. The output shall be capable of being accurately converted to a corresponding air flow rate in cubic feet per minute. Transmitters shall be a 2-wire, loop powered device. The output error of the transmitter shall not exceed

0.5 percent of the measurement.

2.2.9 Energy Metering

NOTE: Metering requirements are in the NAVFAC Maintenance Manual, MO-221 Utilities Metering. Also determine local needs of the BAS Owner and show meters on the drawings.

2.2.9.1 Electric Meters

NOTE: Use the first paragraph when electric meters are covered under another section, and delete the second paragraph. Otherwise, delete the first paragraph and use the second.

[Provide kilowatt-hour (kWh) meter(s) shown as specified in Section [_____, "_____"]]

[Provide kilowatt-hour (kWh) meter(s) shown in accordance with NEMA/ANSI C12.10, suitable for the intended voltage, phases, and wye/delta configuration, with three current transformers and an output signal compatible with the DDC system. The meter shall have a box-mounted socket and an automatic circuit-closing bypass. Provide the meter with at least four pointer-type kWh registers, provisions for pulse initiation, and universal Class 2 indicating maximum kW demand register, sweep pointer indicating type, and a [15] [30] [60] minute interval. The meter accuracy shall be within plus or minus one percent of the actual kWh. Provide the correct multiplier on the meter face. Provide the current transformers in accordance with IEEE C57.13, with 600-volt insulation, and rated for metering with voltage, IL, momentary, and burden ratings coordinated with the ratings of corresponding meters. Provide butyl-molded donut or window type transformers mounted on a bracket to allow secondary cables to connect to the transformer bushings. Provide wiring identification of the current transformer secondary feeders to permit field measurements to be taken with hook-on ammeters.]

NOTE: Locate steam meters according to ASME, Fluid Meters; Theory and Applications.

2.2.9.2 Steam Meters

Steam meters shall be the vortex type, with pressure compensation, a minimum turndown ratio of 10 to 1, and an output signal compatible with the DDC system.

2.3 OUTPUT HARDWARE

2.3.1 Control Dampers

NOTE: Show all control dampers on the control drawings. Indicate the blade configuration (parallel or opposed-blade), the actuator normal position, and whether it's two-position or modulating. Where desired, provide a switch on the linkage to indicate the damper status.

Provide factory manufactured [galvanized][stainless] steel dampers where indicated. Control dampers shall comply with SMACNA 1966 except as modified or supplemented by this specification. Published damper leakage rates and respective pressure drops shall have been verified by tests in compliance with AMCA 500-D requirements.

Provide damper assembly frames constructed of 1.62 mm 0.064 inch minimum thickness [galvanized][stainless] steel channels with mitered and welded corners. Damper axles shall be 13 mm 0.5 inches minimum diameter plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings.

Dampers shall be rated for not less than 10 m/s 2000 fpm air velocity. The pressure drop through each damper when full-open shall not exceed 10 Pa water gage at 5 m/s 0.04 inches water gage at 1000 fpm face velocity. Damper assemblies in ductwork subject to above 746 Pa 3-inch water gauge static air pressure shall be constructed to meet SMACNA Seal Class "A" construction requirements.

Provide the damper operating linkages outside of the air stream, including crank arms, connecting rods, and other hardware that transmits motion from the damper actuators to the dampers, shall be adjustable. Additionally, operating linkages shall be designed and constructed to have a 2 to 1 safety factor when loaded with the maximum required damper operating force. Linkages shall be brass, bronze, galvanized steel, or stainless steel.

Provide access doors or panels in hard ceilings and walls for access to all concealed damper operators and damper locking setscrews.

For field-installed control dampers, a single damper section shall have blades no longer than 1220 mm 48 inches and no higher than 1830 mm 72 inches. The maximum damper blade width shall be 305 mm 12 inches. Larger sized dampers shall be built using a combination of sections.

Frames shall be at least 50 mm 2 inches wide. Flat blades shall have edges folded for rigidity. Blades shall be provided with compressible gasket seals along the full length of the blades to prevent air leakage when closed.

The damper frames shall be provided with jamb seals to minimize air leakage. Seals shall be suitable for an operating temperature range of minus 40 degrees C to 93 degrees C minus 40 degrees F to 200 degrees F.

The leakage rate of each damper when full-closed shall be no more than 2 l/s per sq. meter 4 cfm per sq. foot of damper face area at 996 Pa 1.0 inches water gage static pressure.

2.3.2 Control Valves

2.3.2.1 Valve Assembly

NOTE: Select valve Cv so pressure drops are within the constraints of the available pressures, pipe velocities, economy of design, and noise criteria. Do not oversize control valves. Size steam valves using the critical pressure drop (0.45 of absolute

pressure). In the absence of other sizing criteria, size modulating hot and chilled water coil control valves for a pressure drop of 21 kPa 2 psi to 4 psi. List the calculated minimum and maximum Cvs in the drawing's valve schedule.

Valve bodies shall be designed for 125 psig minimum working pressure or 150 percent of the operating pressure, whichever is greater. Valve stems shall be Type 316 stainless steel. Valve leakage ratings shall be 0.01 percent of rated Cv value. Class 125 copper alloy valve bodies and Class 150 steel or stainless steel valves shall meet the requirements of ASME B16.5. Cast iron valve components shall meet the requirements of ASTM A 126 Class B or C.

2.3.2.2 Butterfly Valves

Butterfly valves shall be the threaded lug type suitable for dead-end service and for modulation to the fully-closed position, with stainless steel shafts supported by bearings, non-corrosive discs geometrically interlocked with or bolted to the shaft (no pins), and EPDM seats suitable for temperatures from minus 29 degrees C to plus 121 degrees C minus 20 degrees F to plus 250 degrees F. Valves shall have a means of manual operation independent of the actuator.

2.3.2.3 Two-Way Valves

Two-way modulating valves shall have an equal percentage characteristic.

2.3.2.4 Three-Way Valves

Three-way valves shall have an equal percentage characteristic.

2.3.2.5 Valves for Chilled Water, Condenser Water, and Glycol Fluid Service

- a. Bodies for valves 40 mm 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 50 to 80 mm 2 inches to 3 inches inclusive shall be of brass, bronze, or iron. Bodies for 50 mm 2 inch valves shall have threaded connections. Bodies for valves from 65 to 80 mm 2-1/2 to 3 inches shall have flanged connections.
- b. Internal valve trim shall be brass or bronze, except that valve stems shall be stainless steel.
- c. Unless indicated otherwise, provide modulating valves sized for 2 psi minimum and 4 psi maximum differential across the valve at the design flow rate.
- d. Valves 100 mm 4 inches and larger shall be butterfly valves, unless indicated otherwise.

2.3.2.6 Valves for Hot Water Service

Valves for hot water service below 121 degrees C 250 Degrees F:

- a. Bodies for valves 40 mm 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 50 to 80 mm

2 inches to 3 inches inclusive shall be of brass, bronze, or iron. Bodies for 50 mm 2 inch valves shall have threaded connections. Bodies for valves from 65 to 80 mm 2-1/2 to 3 inches shall have flanged connections.

- b. Internal trim (including seats, seat rings, modulation plugs, valve stems, and springs) of valves controlling water above 99 degrees C 210 degrees F shall be Type 316 stainless steel.
- c. Internal trim for valves controlling water 99 degrees C 210 degrees F or less shall be brass or bronze. Valve stems shall be Type 316 stainless steel.
- d. Non-metallic parts of hot water control valves shall be suitable for a minimum continuous operating temperature of 121 degrees C or 28 degrees C 250 degrees F or 50 degrees F above the system design temperature, whichever is higher.
- e. Unless indicated otherwise, provide modulating valves sized for 2 psi minimum and 4 psi maximum differential across the valve at the design flow rate.
- f. Valves 100 mm 4 inches and larger shall be butterfly valves, unless indicated otherwise.

2.3.2.7 Valves for High Temperature Hot Water Service

Valves for hot water service 121 degrees C 250 Degrees F above:

- a. Valve bodies shall conform to ASME B16.34 Class 300. Valve and actuator combination shall be normally closed. Bodies shall be carbon steel, globe type with welded ends on valves 25 mm 1 inch and larger. Valves smaller than 25 mm 1 inch shall have socket-weld ends. Packing shall be virgin polytetrafluoroethylene (PTFE).
- b. Internal valve trim shall be Type 316 stainless steel.
- c. Unless indicated otherwise, provide modulating valves sized for 2 psi minimum and 4 psi maximum differential across the valve at the design flow rate.

2.3.2.8 Valves for Steam Service

The entire body for valves 40 mm 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 50 to 80 mm 2 to 3 inches inclusive shall be of brass, bronze, or carbon steel. Bodies for valves 100 mm 4 inches and larger shall be carbon steel. Bodies for 50 mm 2 inch valves shall have threaded connections. Bodies for valves 65 mm 2-1/2 inches and larger shall have flanged connections. Steam valves shall be sized for [103 kPa (gage)] [15 psig] [_____] inlet steam pressure with a maximum [90 kPa] [13 psi] [_____] differential through the valve at rated flow, except where indicated otherwise. Internal valve trim shall be Type 316 stainless steel.

2.3.3 Actuators

Provide direct-drive electric actuators for all control applications, except where indicated otherwise.

NOTE: Show on drawings the normal position of each actuator without power or control signal. Select normal position considering power loss, freezing, moisture damage, and smoke or fire transmission. Indicate power return actuators where necessary for actuator timing and process requirements. Indicate spring return for actuators where normal position, but not timing, is important. Spring return closed is often desirable for steam valves and outside air intake dampers. Whenever possible provide electric actuators for reduced maintenance, quality control, and DDC integration. However, pneumatic actuators may be preferable in unusual circumstances like explosion-proof areas. Existing pneumatic actuators may also have to remain in retrofits where costs prevent actuator replacement.

2.3.3.1 Electric Actuators

Each actuator shall deliver the torque required for continuous uniform motion and shall have internal end switches to limit the travel, or be capable of withstanding continuous stalling without damage. Actuators shall function properly within 85 to 110 percent of rated line voltage. Provide actuators with hardened steel running shafts and gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch-pounds. Provide two-position actuators of single direction, spring return, or reversing type. Provide modulating actuators capable of stopping at any point in the cycle, and starting in either direction from any point. Actuators shall be equipped with a switch for reversing direction, and a button to disengage the clutch to allow manual adjustments. Provide the actuator with a hand crank for manual adjustments, as applicable. Thermal type actuators may only be used on terminal fan coil units, terminal VAV units, convectors, and unit heaters. Spring return actuators shall be provided on all control dampers and all control valves except terminal fan coil units, terminal VAV units, convectors, and unit heaters; unless indicated otherwise. Each actuator shall have distinct markings indicating the full-open and full-closed position, and the points in-between.

2.3.3.2 Pneumatic Actuators

NOTE: Delete this paragraph and the following subparagraphs for pneumatic devices if not used.

Provide piston or diaphragm type actuators

2.3.4 Output Signal Conversion

2.3.4.1 Electronic-to-Pneumatic Transducers

Electronic to pneumatic transducers shall convert a 4 to 20 mA or 0 to 10 VDC digital controller output signal to a proportional 0 to 20 psig pressure signal (operator scaleable). Accuracy and linearity shall be 1.0 percent or better. [Transducers shall have feedback circuit that converts the pneumatic signal to a proportional 4 to 20 mA or 0 to 10 VDC signal.]

2.3.5 Output Switches

2.3.5.1 Control Relays

Field installed and DDC panel relays shall be double pole, double throw, UL listed, with contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light shall be lit when the coil is energized and off when coil is not energized. Relays shall be the socket type, plug into a fixed base, and replaceable without tools or removing wiring. Encapsulated "PAM" type relays may be used for terminal control applications.

2.4 ELECTRICAL POWER AND DISTRIBUTION

NOTE: In most cases, use Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, for specifying electrical power and wiring. Delete redundant or ambiguous paragraphs from this specification section upon coordination with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM .

2.4.1 Transformers

Transformers shall conform to UL 506. For control power other than terminal level equipment, provide a fuse or circuit breaker on the secondary side of each transformer.

2.4.2 Surge and Transient Protection

Provide each digital controller with surge and transient power protection. Surge and transient protection shall consist of the following devices, installed externally to the controllers.

2.4.2.1 Power Line Surge Protection

Provide surge suppressors on the incoming power at each controller or grouped terminal controllers. Surge suppressors shall be rated in accordance with UL 1449, have a fault indicating light, and conform to the following:

- a. The device shall be a transient voltage surge suppressor, hard-wire type individual equipment protector for 120 VAC/1 phase/2 wire plus ground.
- b. The device shall react within 5 nanoseconds and automatically reset.
- c. The voltage protection threshold, line to neutral, shall be no more than 211 volts.
- d. The device shall have an independent secondary stage equal to or greater than the primary stage joule rating.
- e. The primary suppression system components shall be pure silicon avalanche diodes.

- f. The secondary suppression system components shall be silicon avalanche diodes or metal oxide varistors.
- g. The device shall have an indication light to indicate the protection components are functioning.
- h. All system functions of the transient suppression system shall be individually fused and not short circuit the AC power line at any time.
- i. The device shall have an EMI/RFI noise filter with a minimum attenuation of 13 dB at 10 kHz to 300 MHz.
- j. The device shall comply with IEEE C62.41.1 and IEEE C62.41.2, Class "B" requirements and be tested according to IEEE C62.45.
- k. The device shall be capable of operating between minus 20 degrees F and plus 122 degrees F.

2.4.2.2 Telephone and Communication Line Surge Protection

Provide surge and transient protection for DDC controllers and DDC network related devices connected to phone and network communication lines, in accordance with the following:

- a. The device shall provide continuous, non-interrupting protection, and shall automatically reset after safely eliminating transient surges.
- b. The protection shall react within 5 nanoseconds using only solid-state silicon avalanche technology.
- c. The device shall be installed at the distance recommended by its manufacturer.

2.4.2.3 Controller Input/Output Protection

Provide controller inputs and outputs with surge protection via optical isolation, metal oxide varistors (MOV), or silicon avalanche devices. Fuses are not permitted for surge protection.

2.4.3 Wiring

Provide complete electrical wiring for the DDC System, including wiring to transformer primaries. Unless indicated otherwise, provide all normally visible or otherwise exposed wiring in conduit. Where conduit is required, control circuit wiring shall not run in the same conduit as power wiring over 100 volts. [Circuits operating at more than 100 volts shall be in accordance with Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM.] Run all circuits over 100 volts in conduit, metallic tubing, covered metal raceways, or armored cable. Use plenum-rated cable for circuits under 100 volts in enclosed spaces. Examples of these spaces include HVAC plenums, within walls, above suspended ceilings, in attics, and within ductwork.

2.4.3.1 Power Wiring

The following requirements are for field-installed wiring:

- a. Wiring for 24 V circuits shall be insulated copper 18 AWG minimum and rated for 300 VAC service.
- b. Wiring for 120 V circuits shall be insulated copper 14 AWG minimum and rated for 600 VAC service.

2.4.3.2 Analog Signal Wiring

Field-installed analog signal wiring shall be 18 AWG single or multiple twisted pair. Each cable shall be 100 percent shielded and have a 20 AWG drain wire. Each wire shall have insulation rated for 300 VAC service. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape.

2.5 FIRE PROTECTION DEVICES

2.5.1 Duct Smoke Detectors

Provide duct smoke detectors in HVAC ducts in accordance with NFPA 72 and NFPA 90A, except as indicated otherwise. Provide UL listed or FM approved detectors, designed specifically for duct installation.

 NOTE: Choose one of the three paragraphs below. Use the following paragraph (and delete the other two) if the project includes Section 28 31 74.00 20 INTERIOR FIRE DETECTION AND ALARM SYSTEM

[Furnish detectors under Section 28 31 74.00 20 INTERIOR FIRE DETECTION AND ALARM SYSTEM and install under this section. Connect new detectors to the building fire alarm panel.]

 NOTE: Use the following paragraph (and delete the other two) if the building has an existing fire alarm system. For connection to the existing system, the designer must determine if the existing fire alarm control panel is compatible with smoke detectors and has spare zone capacity. When in doubt, leave the choice of a connection to the fire alarm panel or a separate control unit in the paragraph. For some antiquated alarm systems, it may be necessary to replace the control panel, then Section UFGS 28 31 74.00 20 INTERIOR FIRE DETECTION AND ALARM SYSTEM must be included in the project, and the previous paragraph would be used.

[Provide [ionization] [or] [photoelectric] type detectors. Detectors shall detect both visible and invisible particles of combustion, and shall not be susceptible to undesired operation by changes to relative humidity. Provide each detector with an approved duct housing mounted exterior to the duct, and an integral perforated sampling tube extending across the width of the duct. The detector housing shall have indicator lamps that light when the detector is powered and when the detector is activated. Each detector shall have an integral test port [, test switch] [and] [or] [, remote keyed test device]. Connect new detectors to the building's [new] [existing] fire alarm control panel. Provide control and power modules

required for the operation of the detectors [in their own new control unit] [or] [integral with the existing fire alarm panel]. A ground fault, break, or open condition in the electrical circuitry to any detector or its control or power unit shall cause activation of a trouble signal at the building fire alarm panel. Electrical supervision of wiring used exclusively for air-handling unit shutdown is not required, provided a break in the wiring would cause shutdown of the associated unit. Equipment and devices shall be compatible and operable in all respects with, and shall in no way impair the reliability or operational functions of, the [new] [existing] fire alarm system. [The building's existing fire alarm control panel was manufactured by [____].] Provide descriptive zone labels at the [new] [existing] fire alarm panel indicating which new air-handling unit detectors they serve and their location. Label zones modified in order to accomplish the work.]

NOTE: Use the paragraph below only with specific approval from NAVFAC Fire Protection Engineering. Approval is normally granted only if the building has no fire alarm system and none is required. When in doubt, contact the regional Fire Protection Engineer.

[Provide [ionization] [or] [photoelectric] type detectors. Detectors shall detect both visible and invisible particles of combustion, and shall not be susceptible to undesired operation by changes to relative humidity. Provide each detector with an approved duct housing mounted exterior to the duct, and an integral perforated sampling tube extending across the width of the duct. The detector housing shall have indicator lamps that light when the detector is powered and when the detector is activated. Each detector shall have an integral test port [, test switch] [and] [or] [, remote keyed test device]. Provide a 115 VAC power supply unit integral with the detector's duct housing. Provide power to the detector from [the air-handling unit or air-handling unit controls] [the location indicated]. [Provide the detectors with a remote alarm indicator [and keyed test] device at [____] [the location indicated].] [Provide each detector with a minimum 152 mm 6 inch diameter remote alarm bell located [as directed][as indicated] in a normally occupied area.] Activation of a detector shall cause immediate shutdown of the associated air-handling unit [and the closing of its dampers][and shall activate the remote alarm indicator][and shall sound the remote alarm bell]. [Provide the remote alarm bell with a permanent label indicating its associated air-handling unit and air-handling unit location.]]

[Provide smoke control systems with a provision for manual operation by means of a key-operated switch to override the duct smoke detector shutdowns. Locate the override switch [adjacent to the building's fire alarm system control panel][as indicated].]

2.6 INDICATORS

2.6.1 Thermometers

Provide bi-metal type thermometers at locations shown. Thermometers shall have either 9 inch long scales or 3.5 inch diameter dials, with insertion, immersion, or averaging elements. Provide matching thermowells for pipe-mounted installations. Select scale ranges suitable for the intended service, with the normal operating temperature near the scale's midpoint.

The thermometer's accuracy shall be plus or minus 2 percent of the scale range.

2.6.2 Pressure Gauges for Piping Systems

Provide pipe-mounted pressure gauges at the locations shown. Gauges shall conform to ASME B40.100 and have a 4-inch diameter dial and shutoff cock. Provide gauges in steam piping with a pressure snubber pigtail fitting. Select scale ranges suitable for the intended service, with the normal operating pressure near the scale's midpoint. The gauge's accuracy shall be plus or minus 2 percent of the scale range.

2.6.3 Pressure Gauges for Pneumatic Controls

NOTE: Delete the following paragraph if pneumatic controls are not used.

Provide a pressure gauge at each pneumatic control input and output. Gauges shall have a 2-inch diameter face and a 0 to 30 psi scale with 1 psi graduations.

2.7 PNEUMATIC POWER SUPPLY AND TUBING

NOTE: Delete this paragraph and the following subparagraphs if there are no new pneumatic compressors or control tubing work; otherwise edit accordingly.

2.7.1 Air Compressors

NOTE: Indicate new compressed air station locations on the drawings. Locate compressors away from quiet occupied spaces. Mount compressors on concrete housekeeping pads adjacent to a wall and mount dryers on the wall. Provide means of draining the compressed air tank. Provide duplex air compressors for systems having more than 50 control air devices, or requiring more than 1.5 CFM of air. Size duplex air compressors for 50 percent run time, and size single air compressors for 33 percent run time. Show power sources for compressors and dryers.

Air compressors for pneumatic control systems shall be the tank-mounted, electric motor driven, air cooled, reciprocating type with integral [duplex motors and compressors][single motor and compressor], tank, controller, [alternator switch,]pressure switch, belt guard[s], pressure relief valve, and automatic moisture drain valve. Compressor piston speeds shall not exceed 450 fpm. Provide compressors with a dry-type combination intake air filter and silencer with baked enamel steel housing. The filter shall be 99 percent efficient at 10 microns. The pressure switch shall start the compressor[s] at 70 psig and stop the compressor[s] at 90 psig. The relief valve shall be set for 10 to 25 psig above the control switch cut-off pressure. Provide compressor capacity suitable for not more than a [33]

[50] percent run time, at full system control load. Compressors shall have a maintaining type starter, and shall automatically restart after a power outage. Motors 0.5 hp and larger shall be three-phase.

2.7.1.1 Compressed Air Tank

Provide a steel tank constructed and labeled in agreement with ASME BPVC for 125 psig maximum working pressure. Size the tank for the compressor run time specified above. Provide drain valve and piping routing the drainage to a floor sink or other safe and visible drainage location.

2.7.2 Refrigerated Air Dryers

Provide each air compressor tank with a refrigerant air dryer sized for continuous operation, and capable of reducing the compressed air dew point temperature, at 20 psig output pressure, to 30 degrees F, at an average tank pressure of 80 psig and an ambient air temperature between 55 and 95 degrees F. Provide each dryer with an automatic condensate drain trap with manual override feature. Provide the dryer suction line with a refrigerant pressure gauge. Locate each dryer in the air piping between the tank and the pressure-reducing station.

2.7.3 Compressed Air Discharge Filters

Provide air compressors with a dry type discharge filter, 99 percent efficient at removing oil and solid particles at 0.03 microns, with baked enamel steel housing and manual drain valve. Provide visual indicator to show when the filter element should be changed.

2.7.4 Air Pressure-Reducing Stations

Provide air compressors with a pressure-reducing valve (PRV) with a field adjustable range of 0 to 50 psig discharge pressure, at an inlet pressure of 70 to 90 psig. Provide a factory-set pressure relief valve downstream of the PRV to relieve over-pressure. Provide a pressure gage upstream of the PRV with range of 0 to 100 psig and downstream of the PRV with range of 0 to 30 psig. For two-pressure control systems, provide an additional PRV and downstream pressure gage.

2.7.5 In-line Filters

Provide a disposable type in-line filter in the incoming pneumatic main at each pneumatic control panel. The filter shall be capable of eliminating 99.99 percent of all liquid or solid contaminants 0.1 micron or larger. Provide the filter with fittings that allow easy removal/replacement.

2.7.6 Pneumatic Tubing

NOTE: Smoke removal and other critical systems
require non-combustible tubing.

2.7.6.1 Copper Tubing

Provide ASTM B 75 or ASTM B 88M ASTM B 88 rated tubing. Tubing 0.64 mm 0.375 inch outside diameter and larger shall have minimum wall thickness equal to ASTM B 88M ASTM B 88, Type M. Tubing less than 10 mm 0.375 inch outside diameter shall have minimum wall thickness of 0.64 mm 0.025 inch.

Exposed tubing and tubing for working pressures greater than 30 psig shall be hard copper. Fittings shall be ASME B16.18 or ASME B16.22 solder type using ASTM B 32 95-5 tin-antimony solder, or ASME B16.26 compression type.

2.7.6.2 Polyethylene Tubing

Polyethylene tubing may only be used in systems with working pressure of 30 psig or less. Provide flame-resistant, multiple polyethylene tubing in flame-resistant protective sheath with mylar barrier, or unsheathed polyethylene tubing in rigid metal, intermediate metal, or electrical metallic tubing conduit for areas where tubing is exposed. Single, unsheathed, flame-resistant polyethylene tubing may be used where concealed in walls or above ceilings and within control panels. Do not provide polyethylene tubing for [systems indicated as critical and] smoke removal systems. Provide compression or brass barbed push-on type fittings. Extruded seamless polyethylene tubing shall conform to the following:

- a. Minimum Burst Pressure Requirements: 690 kPa 100 psig at 24 degrees C 75 degrees F to 172 kPa 25 psig at 66 degrees C 150 degrees F.
- b. Stress Crack Resistance: ASTM D 1693, 200 hours minimum.
- c. Tensile Strength (Minimum): ASTM D 638, 7583 kPa 1100 psi.
- d. Flow Rate (Average): ASTM D 1238, 0.30 decigram per minute.
- e. Density (Average): ASTM D 792, 920 kg/m3 57.5 pounds per cubic feet.
- f. Burn rate: ASTM D 635

2.8 VARIABLE FREQUENCY (MOTOR) DRIVES

NOTE: Delete the following section if variable frequency motor drives are not used, or are provided under another section.

Provide variable frequency drives (VFDs) as indicated. VFDs shall convert 240 or 460 volt (plus or minus 10 percent), three phase, 60 hertz (plus or minus 2Hz), utility grade power to adjustable voltage/frequency, three phase, AC power for stepless motor control from 5 percent to 105 percent of base speed. VFDs shall be UL listed as delivered to the end user. The VFD shall meet the requirements specified in the most current National Electrical Code. Each VFD shall also meet the following:

- a. The VFD shall use sine coded Pulse Width Modulation (PWM) technology. PWM calculations shall be performed by the VFD microprocessor.
- b. The VFD shall be capable of automatic control by a remote 4-20 mA [0 to 10 VDC] signal, by network command, or manually by the VFD control panel.

2.8.1 VFD Quality Assurance

VFDs shall be the manufacturer's current standard production unit with at least 10 identical units successfully operating in the field.

2.8.2 VFD Service Support

- a. **Warranty:** Provide the VFDs with a minimum 24-month full parts and labor warranty. The warranty shall start when the contract's HVAC system is accepted by the Government. Include warranty documentation, dates, and contact information with the VFD on-site service manuals.
- b. **VFD Service Manuals:** Provide the VFDs with all necessary installation, operation, maintenance, troubleshooting, service, and repair manuals in English including related factory technical bulletins. Provide the documents factory bound, in sturdy 3-ring binders, or hard bound covers. Provide a title sheet on the outside of each binder indicating the project title, project location, installing contractor, contract number, and the VFD manufacturer, address, and telephone number. Each binder shall include a table of contents and tabbed dividers, with all material neatly organized. The documentation provided shall be specifically applicable to this project, shall be annotated to reflect the actual project conditions, and shall provide a complete and concise depiction of the installed work.[Provide a storage cabinet on or near the VFD large enough to hold all of the documentation. Have the cabinet's proposed installation site approved in advance by the Contracting Officer. Prominently label the cabinet "VFD OPERATION AND MAINTENANCE MANUALS." Clearly label each manual with the wording "MECHANICAL ROOM COPY - DO NOT REMOVE".]
- c. **Technical Support:** Provide the VFDs with manufacturer's technical telephone support in English, readily available during normal working hours, and free of charge for the life of the equipment.
- d. **Initial Start-Up:** Provide the VFDs with factory-trained personnel for the on-site start-up of the HVAC equipment and associated VFD. The personnel shall be competent in the complete start-up, operation, and repair of the particular model VFD installed. The factory start-up representative shall perform the factory's complete recommended start-up procedures and check-out tests on the VFD. Include a copy of the start-up test documentation with the VFD on-site service manuals.
- e. Provide the VFDs with on-site/hands-on training for the user and maintenance personnel. Provide a capable and qualified instructor with minimum two years field experience with the operation and maintenance of similar VFDs. The training shall occur during normal working hours and last not less than 2 hours. Coordinate the training time with the Contracting Officer and the end user. The VFD service manuals shall be used during the training. The contractor shall ensure the manuals are on-site before the start of training. The training shall cover all operational aspects of the VFD.

2.8.3 VFD Features

VFDs shall have the following features:

- a. A local operator control keypad capable of:
 - (1) Remote/Local operator selection with password access.
 - (2) Run/Stop and manual speed commands.
 - (3) All programming functions.

- (4) Scrolling through all display functions.
 - b. Digital display capable of indicating:
 - (1) VFD status.
 - (2) Frequency.
 - (3) Motor RPM.
 - (4) Phase current.
 - (5) Fault diagnostics in descriptive text.
 - (6) All programmed parameters.
 - c. Standard PI loop controller with input terminal for controlled variable and parameter settings.
 - d. User interface terminals for remote control of VFD speed, speed feedback, and an isolated form C SPDT relay, which energizes on a drive fault condition.
 - e. An isolated form C SPDT auxiliary relay which energizes on a run command.
 - f. A metal NEMA 1 enclosure for indoors, NEMA 4 with heater for outdoors.
 - g. An adjustable carrier frequency with 16 KHz minimum upper limit.
 - h. A built in or external line reactor with 3 percent minimum impedance to protect the VFDs DC buss capacitors and rectifier section diodes.
- 2.8.4 Programmable Parameters

VFDs shall include the following operator programmable parameters:

- a. Upper and lower limit frequency.
- b. Acceleration and Deceleration rate.
- c. Variable torque volts per Hertz curve.
- d. Starting voltage level.
- e. Starting frequency level.
- f. Display speed scaling.
- g. Enable/disable auto-restart feature.
- h. Enable/disable soft stall feature.
- i. Motor overload level.
- j. Motor stall level.
- k. Jump frequency and hysteresis band.

1. PWM carrier frequency.

2.8.5 Protective Features

VFDs shall have the following protective features:

- a. An electronic adjustable inverse time current limit with consideration for additional heating of the motor at frequencies below 45Hz, for the protection of the motor.
- b. An electronic adjustable soft stall feature, allowing the VFD to lower the frequency to a point where the motor will not exceed the full-load amperage when an overload condition exists at the requested frequency. The VFD will automatically return to the requested frequency when load conditions permit.
- c. A separate electronic stall at 110 percent VFD rated current, and a separate hardware trip at 190 percent current.
- d. Ground fault protection that protects the output cables and motor from grounds during both starting and continuous running conditions.
- e. The ability to restart after the following faults:
 - (1) Overcurrent (drive or motor).
 - (2) Power outage.
 - (3) Phase loss.
 - (4) Over voltage/Under voltage.
- f. The ability shut down if inadvertently started into a rotating load without damaging the VFD or the motor.
- g. The ability to keep a log of a minimum of four previous fault conditions, indicating the fault type and time of occurrence in descriptive text.
- h. The ability to sustain 110 percent rated current for 60 seconds
- i. The ability to shutdown safely or protect against and record the following fault conditions:
 - (1) Over current (and an indication if the over current was during acceleration, deceleration, or running).
 - (2) Over current internal to the drive.
 - (3) Motor overload at start-up.
 - (4) Over voltage from utility power.
 - (5) Motor running overload.
 - (6) Over voltage during deceleration.
 - (7) VFD over heat.

(8) Load end ground fault.

(9) Abnormal parameters or data in VFD EEPROM.

2.8.6 Minimum Operating Conditions

VFDs shall be designed and constructed to operate within the following service conditions:

- a. Ambient Temperature Range, 0 to 120 degrees F.
- b. Non-condensing relative humidity to 90 percent.

2.8.7 Additional Features

Provide VFDs with the following additional features:

- [a. BACnet communication interface port]
- [b. RFI/EMI filters]
- [c. Manual bypass circuit and switch integral [external] to the drive to allow drive bypass and operation at 100 percent speed. Motor overload and short circuit protective features shall remain in use during the bypass mode.]
- [d. One spare VFD of each model provided, fully programmed and ready for back-up operation when connected.]

PART 3 EXECUTION

3.1 INSTALLATION

Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.

NOTE: Provide or coordinate a list of standardized names, BACnet project numbers, device and network addresses, and priority level assignments with the Contractor and BAS Owner early in the project. If no list exists, develop one prior to contract award.

3.1.1 BACnet Naming and Addressing

Coordinate with the BAS Owner and provide unique naming and addressing for BACnet networks and devices.

a. MAC Address

Every BACnet device shall have an assigned and documented MAC Address unique to its network. For Ethernet networks, document the MAC Address assigned at its creation. For ARCNET or MS/TP, assign from 00 to 64.

b. Network Numbering

Assign unique numbers to each new network installed on the BACnet

internetwork. Provide ability for changing the network number; either by device switches, network computer, or field operator interface. The BACnet internetwork (all possible connected networks) can contain up to 65,534 possible unique networks.

c. Device Object Identifier Property Number

Assign unique Device "Object_Identifier" property numbers or device instances for each device on the BACnet internetwork. Provide for future modification of the device instance number; either by device switches, network computer, or field interface. BACnet allows up to 4,194,302 possible unique devices per internetwork.

d. Device Object Name Property Text

The Device Object Name property field shall support 32 minimum printable characters. Assign unique Device "Object_Name" property names with plain-English descriptive names for each device. For example, the Device Object Name that for the device controlling the chiller plant at Building 3408 would be:

Device Object_Name = CW System B3408

A Device Object Name for a VAV box controller might be:

Device Object_Name = VAV BOX25

e. Object Name Property Text (Other than Device Objects)

The Object Name property field shall support 32 minimum printable characters. Assign Object Name properties with plain-English names descriptive of the application. Examples include "Zone 1 Temperature" and "Fan Start/Stop".

f. Object Identifier Property Number (Other than Device Objects)

Assign Object Identifier property numbers according to design drawings or tables if provided. If not provided, Object Identifier property numbers may be assigned at the Contractor's discretion but must be approved by the Government. In this case they must be documented and unique for like object types within the device.

3.1.2 Minimum BACnet Object Requirements

a. Use of Standard BACnet Objects

For the following points and parameters, use standard BACnet objects, where all relevant object properties can be read using BACnet's Read Property Service, and all relevant object properties can be modified using BACnet's Write Property Service:
all device physical inputs and outputs, all set points, all PID tuning parameters, all calculated pressures, flow rates, and consumption values, all alarms, all trends, all schedules, and all equipment and lighting circuit operating status.

b. BACnet Object Description Property

The Object Description property shall support 32 minimum printable characters. For each object, complete the description property field

using a brief, narrative, plain English description specific to the object and project application. For example: "HW Pump 1 Proof." Document compliance, length restrictions, and whether the description is writeable in the device PICS.

c. Analog Input, Output, and Value Objects

Support and provide Description and/or Device_Type text strings matching signal type and engineering units shown on the points list.

d. Binary Input, Output, and Value Objects

Support and provide Inactive_Text and Active_Text property descriptions matching conditions shown on the points list.

e. Calendar Object

For devices with scheduling capability, provide at least one Calendar Object with ten-entry capacity. All operators may view Calendar Objects; authorized operators may make modifications from a workstation. Enable the writeable Date List property and support all calendar entry data types.

f. Schedule Object

Use Schedule Objects for all building system scheduling. All operators may view schedule entries; authorized operators may modify schedules from a workstation.

g. Loop Object or Equal

Use Loop Objects or equivalent BACnet objects in each applicable field device for PID control. Regardless of program method or object used, allow authorized operators to adjust the Update Interval, Setpoint, Proportional Constant, Integral Constant, and Derivative Constant using BACnet read/write services.

3.1.3 Minimum BACnet Service Requirements

a. Command Priorities

Use commandable BACnet objects to control machinery and systems, providing the priority levels listed below. If the sequence of operation requires a different priority, obtain approval from the Contracting Officer.

<u>Priority Level</u>	<u>Application</u>
1	Manual-Life Safety
2	Automatic-Life Safety
3	(User Defined)
4	(User Defined)
5	Critical Equipment Control
6	Minimum On/Off
7	(User Defined)
8	Manual Operator
9	(User Defined)
10	(User Defined)
11	Load Shedding
12	(User Defined)

- 13 (User Defined)
- 14 (User Defined)
- 15 (User Defined)
- 16 (User Defined)

b. Alarming

- (1) Alarm Priorities - Coordinate alarm and event notification with the BAS Owner.
- (2) Notification Class - Enable writeable Priority, Ack Required, and Recipient List properties of Notification Class objects.
- (3) Event Notification Message Texts - Use condition specific narrative text and numerical references for alarm and event notification.

c. Updating Displayed Property Values

Allow workstations to display property values at discrete polled intervals, or based on receipt of confirmed and unconfirmed Change of Value notifications. The COV increment shall be adjustable by an operator using BACnet services, and polled intervals shall be adjustable at the operator workstation.

3.1.4 Local Area Networks

Obtain Government approval before connecting new networks with existing networks. Network numbers and device instance numbers shall remain unique when joining networks. Do not change existing network addressing without Government approval. See also "BACnet Naming and Addressing".

3.1.5 BACnet Routers, Bridges, and Switches

Provide the quantity of BACnet routers, bridges, and switches necessary for communications shown on the BACnet Communication Architecture schematic. Provide BACnet routers with BACnet Broadcast Message Device (BBMD) capability on each BACnet internetwork communicating across an IP network. Configure each BACnet device and bridge, router, or switch to communicate on its network segment.

3.1.6 Wiring Criteria

- a. Run circuits operating at more than 100 volts in rigid or flexible conduit, metallic tubing, covered metal raceways, or armored cable.
- b. Do not run binary control circuit wiring in the same conduit as power wiring over 100 volts. Where analog signal wiring requires conduit, do not run in the same conduit with AC power circuits or control circuits operating at more than 100 volts.
- c. Provide circuit and wiring protection required by NFPA 70.
- d. Run all wiring located inside mechanical rooms in conduit.
- e. Do not bury aluminum-sheathed cable or aluminum conduit in concrete.
- f. Input/output identification: Permanently label each field-installed wire, cable, and pneumatic tube at each end with descriptive text using

a commercial wire marking system that fully encircles the wire, cable, or tube. Locate the markers within 2 inches of each termination. Match the names and I/O number to the project's point list. Similarly label all power wiring serving control devices, including the word "power" in the label. Number each pneumatic tube every six feet. Label all terminal blocks with alpha/numeric labels. All wiring and the wiring methods shall be in accordance with [UL 508A](#).

- g. For controller power, provide new 120 VAC circuits, with ground. Provide each circuit with a dedicated breaker, and run wiring in its own conduit, separate from any control wiring. Connect the controller's ground wire to the electrical panel ground; conduit grounds are not acceptable.
- h. Surge Protection: Install surge protection according to manufacturer's instructions. Multiple controllers fed from a common power supply may be protected by a common surge protector, properly sized for the total connected devices.
- i. Grounding: Ground controllers and cabinets to a good earth ground as specified in Section [26 20 00](#) INTERIOR DISTRIBUTION SYSTEM. Conduit grounding is not acceptable; all grounding shall have a direct path to the building earth ground. Ground sensor drain wire shields at the controller end.
- j. The Contractor shall be responsible for correcting all associated ground loop problems.
- k. Run wiring in panel enclosures in covered wire track.

3.1.7 Accessibility

Install all equipment so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install digital controllers, data ports, and concealed actuators, valves, dampers, and like equipment in locations freely accessible through access doors.

3.1.8 Digital Controllers

- a. Install as stand alone control devices (see definitions).
- b. Locate control cabinets at the locations shown on the drawings. If not shown on the drawings, install in the most accessible space, close to the controlled equipment.

3.1.9 Hand-Off-Auto Switches

Wire safety controls such as smoke detectors and freeze protection thermostats to protect the equipment during both hand and auto operation.

3.1.10 Temperature Sensors

Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate sensors according to manufacturer's instructions. Do not use sensors designed for one application in a different application.

3.1.10.1 Room Temperature Sensors

Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of the sensor [5 feet above the finished floor][54 inches above the floor to meet ADA requirements][at the height[s] indicated].

3.1.10.2 Duct Temperature Sensors

- a. Probe Type: Provide a gasket between the sensor housing and the duct wall. Seal the duct penetration air tight. Seal the duct insulation penetration vapor tight.
- b. Averaging Type (and coil freeze protection thermostats): Weave the capillary tube sensing element in a serpentine fashion perpendicular to the flow, across the duct or air handler cross-section, using durable non-metal supports. Prevent contact between the capillary and the duct or air handler internals. Provide a duct access door at the sensor location. The access door shall be hinged on the side, factory insulated, have cam type locks, and be as large as the duct will permit, maximum 18 by 18 inches. For sensors inside air handlers, the sensors shall be fully accessible through the air handler's access doors without removing any of the air handler's internals.

3.1.10.3 Immersion Temperature Sensors

Provide thermowells for sensors measuring piping, tank, or pressure vessel temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to sense flow across entire area of well. Wells shall not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide thermal conductivity material within the well to fully coat the inserted sensor.

3.1.10.4 Outside Air Temperature Sensors

NOTE: Show the OA temperature sensor on the north side of the building on the drawings.

Provide outside air temperature sensors in weatherproof enclosures on the north side of the building, away from exhaust hoods and other areas that may affect the reading. Provide a shield to shade the sensor from direct sunlight.

3.1.11 Energy Meters

Locate energy meters as indicated. Connect each meter output to the DDC system, to measure both instantaneous and accumulated energy usage.

3.1.12 Damper Actuators

Where possible, mount actuators outside the air stream in accessible areas.

3.1.13 Thermometers and Gages

Mount devices to allow reading while standing on the floor or ground, as applicable.

3.1.14 Pressure Sensors

Locate pressure sensors as indicated.

[3.1.15 Pneumatic Tubing

Run tubing concealed in finished areas, run tubing exposed in unfinished areas like mechanical rooms. For tubing enclosed in concrete, provide rigid metal conduit. Run tubing parallel and perpendicular to building walls. Use 5 foot maximum spacing between tubing supports. With the compressor turned off, test each tubing system pneumatically at 1.5 times the working pressure and prove it air tight, locating and correcting leaks as applicable. Caulking joints is not permitted. Do not run tubing and electrical power conductors in the same conduit.]

3.1.16 Component Identification Labeling

Using an electronic hand-held label maker with white tape and bold black block lettering, provide an identification label on the exterior of each new control panel, control device, actuator, and sensor. Also provide labels on the exterior of each new control actuator indicating the (full) open and (full) closed positions. For labels located outdoors, use exterior grade label tape, and provide labels on both the inside and outside of the panel door or device cover. Acceptable alternatives are white plastic labels with engraved bold black block lettering permanently attached to the control panel, control device, actuator, and sensor. Have the labels and wording approved by the BAS Owner prior to installation.

3.1.17 Network and Telephone Communication Lines

When telephone lines or network connections by the Government are required, provide the Contracting Officer at least 60 days advance notice of need.

3.2 TEST AND BALANCE SUPPORT

The controls contractor shall coordinate with and provide on-site support to the test and balance (TAB) personnel [specified under Section 23 05 93 TESTING, ADJUSTING AND BALANCING.] This support shall include:

- a. On-site operation and manipulation of control systems during the testing and balancing.
- b. Control setpoint adjustments for balancing all relevant mechanical systems, including VAV boxes.
- c. Tuning control loops with setpoints and adjustments determined by TAB personnel.

3.3 CONTROLS SYSTEM OPERATORS MANUALS

Provide two [three] [four] electronic and printed copies of a Controls System Operators Manual. The manual shall be specific to the project, written to actual project conditions, and provide a complete and concise depiction of the installed work. Provide information in detail to clearly

explain all operation requirements for the control system.

Provide with each manual: CDs of the project's control system drawings, control programs, data bases, graphics, and all items listed below. Include gateway back-up data and configuration tools where applicable. Provide CDs in jewel case with printed and dated project-specific labels on both the CD and the case. For text and drawings, use Adobe Acrobat or MS Office file types. When approved by the Government, AutoCAD and Visio files are allowed. Give files descriptive English names and organize in folders.

Provide printed manuals in sturdy 3-ring binders with a title sheet on the outside of each binder indicating the project title, project location, contract number, and the controls contractor name, address, and telephone number. Each binder shall include a table of contents and tabbed dividers, with all material neatly organized. Manuals shall include the following:

- a. A copy of the as-built control system (shop) drawings set, with all items specified under the paragraph "Submittals." Indicate all field changes and modifications.
- b. A copy of the project's mechanical design drawings, including any official modifications and revisions.
- c. A copy of the project's approved Product Data submittals provided under the paragraph "Submittals."
- d. A copy of the project's approved Performance Verification Testing Plan and Report.
- e. A copy of the project's approved final TAB Report.
- f. Printouts of all control system programs, including controller setup pages if used. Include plain-English narratives of application programs, flowcharts, and source code.
- g. Printouts of all physical input and output object properties, including tuning values, alarm limits, calibration factors, and set points.
- h. A table entitled "AC Power Table" listing the electrical power source for each controller. Include the building electrical panel number, panel location, and circuit breaker number.
- i. The DDC manufacturer's hardware and software manuals in both print and CD format with printed project-specific labels. Include installation and technical manuals for all controller hardware, operator manuals for all controllers, programming manuals for all controllers, operator manuals for all workstation software, installation and technical manuals for the workstation and notebook, and programming manuals for the workstation and notebook software.
- j. A list of qualified control system service organizations for the work provided under this contract. Include their addresses and telephone numbers.
- k. A written statement entitled "Technical Support" stating the control system manufacturer or authorized representative will provide toll-free telephone technical support at no additional cost to the Government for a minimum of two years from project acceptance, will be furnished by

experienced service technicians, and will be available during normal weekday working hours. Include the toll-free technical support telephone number.

1. A written statement entitled "Software Upgrades" stating software and firmware patches and updates will be provided upon request at no additional cost to the Government for a minimum of two years from contract acceptance. Include a table of all DDC system software and firmware provided under this contract, listing the original release dates, version numbers, part numbers, and serial numbers.

[3.3.1 Storage Cabinets

In each project mechanical room, provide a wall-mounted metal storage cabinet with hinged doors. In addition to the number of manuals specified above, provide an additional copy of the manuals in each of these mechanical room storage cabinets. Provide cabinets large enough to hold the entire set of Controls System Operators Manuals, and the HVAC operation and maintenance manuals [provided under Division 15 MECHANICAL.] Locate cabinets adjacent to DDC control panels where applicable. Have each cabinet's proposed installation site approved in advance by the Contracting Officer and the BAS Owner. Prominently label each cabinet with the wording "OPERATION AND MAINTENANCE MANUALS." Prominently label each binder with the wording "MECHANICAL ROOM COPY - DO NOT REMOVE."]

3.4 PERFORMANCE VERIFICATION TESTING (PVT)

3.4.1 General

The PVT shall demonstrate compliance of the control system work with the contract requirements. The PVT shall be performed by the Contractor and witnessed and approved by the Government. If the project is phased, provide separate testing for each phase. A Pre-PVT meeting to review the [Pre-PVT Checklist](#) is required to coordinate all aspects of the PVT and shall include the Contractor's QA representative, the Contractor's PVT administrator, the Contracting Officer's representative, [and the BAS Owner].

3.4.2 [Performance Verification Testing Plan](#)

**NOTE: If possible, give the Contractor early
guidance and examples for creation and content of
PVT procedures and reporting forms.**

Submit a detailed PVT Plan of the proposed testing for Government approval. Develop the PVT Plan specifically for the control system in this contract. The PVT Plan shall be an clear list of test items arranged in a logical sequence. Include the intended test procedure, the expected response, and the pass/fail criteria for every component tested.

The plan shall clearly describe how each item is tested, indicate where assisting personnel are required (like the mechanical contractor), and include what procedures are used to simulate conditions. Include a separate column for each checked item and extra space for comments. Where sequences of operations are checked, insert each corresponding routine from the project's sequence of operation. For each test area, include signature and date lines for the Contractor's PVT administrator, the Contractor's QA

representative, the Contracting Officer's representative, [and the BAS Owner] to acknowledge successful completion. [The BAS Owner can provide sample PVT forms and procedures upon request.]

3.4.3 PVT Sample Size

Test all central plant equipment and primary air handling unit controllers unless otherwise directed. Twenty percent sample testing is allowed for identical controllers typical of terminal control like VAV boxes and fan coil units. The Government may require testing of like controllers beyond a statistical sample if sample controllers require retesting or do not have consistent results.

The Government may witness all testing, or random samples of PVT items. When only random samples are witnessed, the Government may choose which ones.

3.4.4 Pre-Performance Verification Testing Checklist

Submit the following as a list with items checked off once verified. Provide a detailed explanation for any items that are not completed or verified.

- a. Verify all required mechanical installation work is successfully completed, and all HVAC equipment is working correctly (or will be by the time the PVT is conducted).
- b. Verify HVAC motors operate below full-load amperage ratings.
- c. Verify all required control system components, wiring, and accessories are installed.
- d. Verify the installed control system architecture matches approved drawings.
- e. Verify all control circuits operate at the proper voltage and are free from grounds or faults.
- f. Verify all required surge protection is installed.
- g. Verify the A/C Power Table specified in "CONTROLS SYSTEM OPERATORS MANUALS" is accurate.
- h. Verify all DDC network communications function properly, including uploading and downloading programming changes.
- i. Using the BACnet protocol analyzer (if provided or required in this specification), verify communications are error free.
- j. Verify each digital controller's programming is backed up.
- k. Verify all wiring, components, and panels are properly labeled.
- l. Verify all required points are programmed into devices.
- m. Verify all TAB work affecting controls is complete.
- n. Verify all valve and actuator zero and span adjustments are set properly.

- o. Verify all sensor readings are accurate and calibrated.
- p. Verify each control valve and actuator goes to normal position upon loss of power.
- q. Verify all control loops are tuned for smooth and stable operation. View trend data where applicable.
- r. Verify each controller works properly in stand-alone mode.
- s. Verify all safety controls and devices function properly, including freeze protection and interfaces with building fire alarm systems.
- t. Verify all electrical interlocks work properly.
- u. Verify all workstations, notebooks and maintenance personnel interface tools are delivered, all system and database software is installed, and graphic pages are created for each workstation and notebook.
- v. Verify the as-built (shop) control drawings are completed.

3.4.5 Conducting Performance Verification Testing

- a. Conduct Government-witnessed PVT after approval of the PVT Plan and the completed Pre-PVT Checklist. Notify the Contracting Officer of the planned PVT at least 15 days prior to testing. Provide an estimated time table required to perform the testing. Furnish personnel, equipment, instrumentation, and supplies necessary to perform all aspects of the PVT. Ensure that testing personnel are regularly employed in the testing and calibration of DDC systems. Using the project's as-built control system (shop) drawings, the project's mechanical design drawings, the approved Pre-PVT Checklist, and the approved PVT Plan, conduct the PVT.
- b. During testing, identify any items that do not meet the contract requirements and if time permits, conduct immediate repairs and re-test. Otherwise, deficiencies shall be investigated, corrected, and re-tested later. Document each deficiency and corrective action taken.
- c. If re-testing is required, follow the procedures for the initial PVT. The Government may require re-testing of any control system components affected by the original failed test.

3.4.6 Controller Capability and Labeling

Test the following for each controller:

- a. Memory: Demonstrate that programmed data, parameters, and trend/ alarm history collected during normal operation is not lost during power failure.
- b. Direct Connect Interface: Demonstrate the ability to connect directly to each type of digital controller with a portable electronic device like a notebook computer or PDA. Show that maintenance personnel interface tools perform as specified in the manufacturer's technical literature.
- c. Stand Alone Ability: Demonstrate controllers provide stable and

reliable stand-alone operation using default values or other method for values normally read over the network.

- d. Wiring and AC Power: Demonstrate the ability to disconnect any controller safely from its power source using the AC Power Table. Demonstrate the ability to match wiring labels easily with the control drawings. Demonstrate the ability to locate a controller's location using the BACnet Communication Architecture Schematic and floor plans.
- e. Nameplates and Tags: Show the nameplates and tags are accurate and permanently attached to control panel doors, devices, sensors, and actuators.

3.4.7 Workstation and Software Operation

For every user workstation or notebook provided:

- a. Show points lists agree with naming conventions.
- b. Show that graphics are complete.
- c. Show the UPS operates as specified.

3.4.8 BACnet Communications and Interoperability Areas

Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. If available or required in this specification, use a BACnet protocol analyzer to assist with identifying devices, viewing network traffic, and verifying interoperability. These requirements must be met even if there is only one manufacturer of equipment installed. Testing includes the following:

- a. Data Presentation: On each BACnet Operator Workstation, demonstrate graphic display capabilities.
- b. Reading of Any Property: Demonstrate the ability to read and display any used readable object property of any device on the network.
- c. Setpoint and Parameter Modifications: Show the ability to modify all setpoints and tuning parameters in the sequence of control or listed on project schedules. Modifications are made with BACnet messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.
- d. Peer-to-Peer Data Exchange: Show all BACnet devices are installed and configured to perform BACnet read/write services directly (without the need for operator or workstation intervention), to implement the project sequence of operation, and to share global data.
- e. Alarm and Event Management: Show that alarms/events are installed and prioritized according to the BAS Owner. Demonstrate time delays and other logic is set up to avoid nuisance tripping, e.g., no status alarms during unoccupied times or high supply air during cold morning start-up. Show that operators with sufficient privilege can read and write alarm/event parameters for all standard BACnet event types. Show that operators with sufficient privilege can change routing (BACnet notification classes) for each alarm/event including the destination, priority, day of week, time of day, and the type of transition involved (TO-OFF NORMAL, TO-NORMAL, etc.).

- f. Schedule Lists: Show that schedules are configured for start/stop, mode change, occupant overrides, and night setback as defined in the sequence of operations.
- g. Schedule Display and Modification: Show the ability to display any schedule with start and stop times for the calendar year. Show that all calendar entries and schedules are modifiable from any connected workstation by an operator with sufficient privilege.
- h. Archival Storage of Data: Show that data archiving is handled by the operator workstation/server, and local trend archiving and display is accomplished with BACnet Trend Log objects.
- i. Modification of Trend Log Object Parameters: Show that an operator with sufficient privilege can change the logged data points, sampling rate, and trend duration.
- j. Device and Network Management: Show the following capabilities:
 - (1) Display of Device Status Information
 - (2) Display of BACnet Object Information
 - (3) Silencing Devices that are Transmitting Erroneous Data
 - (4) Time Synchronization
 - (5) Remote Device Reinitialization
 - (6) Backup and Restore Device Programming and Master Database(s)
 - (7) Configuration Management of Half-Routers, Routers and BBMDs

3.4.9 Execution of Sequence of Operation

Demonstrate that the HVAC system operates properly through the complete sequence of operation. Use read/write property services to globally read and modify parameters over the internetwork.

3.4.10 Control Loop Stability and Accuracy

For all control loops tested, give the Government trend graphs of the control variable over time, demonstrating that the control loop responds to a 20 percent sudden change of the control variable set point without excessive overshoot and undershoot. If the process does not allow a 20 percent set point change, use the largest change possible. Show that once the new set point is reached, it is stable and maintained. Control loop trend data shall be in real-time with the time between data points 30 seconds or less.

3.4.11 Performance Verification Testing Report

Upon successful completion of the PVT, submit a PVT Report to the Government and prior to the Government taking use and possession of the facility. Do not submit the report until all problems are corrected and successfully re-tested. The report shall include the annotated PVT Plan used during the PVT. Where problems were identified, explain each problem and the corrective action taken. Include a written certification that the

installation and testing of the control system is complete and meets all of the contract's requirements.

3.5 TRAINING REQUIREMENTS

Provide a qualified instructor (or instructors) with two years minimum field experience with the installation and programming of similar BACnet DDC systems. Orient training to the specific systems installed. Coordinate training times with the Contracting Officer and BAS Owner after receiving approval of the training course documentation. Training shall take place at the job site and/or a nearby Government-furnished location. A training day shall occur during normal working hours, last no longer than 8 hours and include a one-hour break for lunch and two additional 15-minute breaks. The project's approved Controls System Operators Manual shall be used as the training text. The Contractor shall ensure the manuals are submitted, approved, and available to hand out to the trainees before the start of training.

3.5.1 Training Documentation

Submit training documentation for review 30 days minimum before training. Documentation shall include an agenda for each training day, objectives, a synopsis of each lesson, and the instructor's background and qualifications. The training documentation can be submitted at the same time as the project's Controls System Operators Manual.

3.5.2 Phase I Training - Fundamentals

The Phase I training session shall last [one day] [two consecutive days] and be conducted in a classroom environment with complete audio-visual aids provided by the contractor. Provide each trainee a printed 8.5 by 11 inch hard-copy of all visual aids used. Upon completion of the Phase I Training, each trainee should fully understand the project's DDC system fundamentals. The training session shall include the following:

- a. BACnet fundamentals (objects, services, addressing) and how/where they are used on this project
- b. This project's list of control system components
- c. This project's list of points and objects
- d. This project's device and network communication architecture
- e. This project's sequences of control, and:
- f. Alarm capabilities
- g. Trending capabilities
- h. Troubleshooting communication errors
- i. Troubleshooting hardware errors

3.5.3 Phase II Training - Operation

Provide Phase II Training shortly after completing Phase I Training. The Phase II training session shall last [one day] [two consecutive days] and be conducted at the DDC system workstation, at a notebook computer

connected to the DDC system in the field, and at other site locations as necessary. Upon completion of the Phase II Training, each trainee should fully understand the project's DDC system operation. The training session shall include the following:

- a. A walk-through tour of the mechanical system and the installed DDC components (controllers, valves, dampers, surge protection, switches, thermostats, sensors, etc.)
- b. A discussion of the components and functions at each DDC panel
- c. Logging-in and navigating at each operator interface type
- d. Using each operator interface to find, read, and write to specific controllers and objects
- e. Modifying and downloading control program changes
- f. Modifying setpoints
- g. Creating, editing, and viewing trends
- h. Creating, editing, and viewing alarms
- i. Creating, editing, and viewing operating schedules and schedule objects
- j. Backing-up and restoring programming and data bases
- k. Modifying graphic text, backgrounds, dynamic data displays, and links to other graphics
- l. Creating new graphics and adding new dynamic data displays and links
- m. Alarm and Event management
- n. Adding and removing network devices

-- End of Section --



REQUEST FOR PROPOSAL



APPENDIX-GG

US ARMY CORPS OF ENGINEERS AIR LEAKAGE TEST PROTOCOL FOR MEASURING AIR LEAKAGE IN BUILDINGS



**US Army Corps
of Engineers®**
Engineer Research and
Development Center

U.S. Army Corps of Engineers Air Leakage Test Protocol for Measuring Air Leakage in Buildings



**U.S. Army Corps of Engineers
Air Leakage Test Protocol for
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CONTENTS

1 INTRODUCTION..... 2

2 USACE REQUIREMENTS FOR BUILDING AIR TIGHTNESS..... 3

2.1 BUILDING AIR TIGHTNESS REQUIREMENT..... 3

2.2 BUILDING AIR LEAKAGE TESTING – PERFORMANCE REQUIREMENT AND SUBSTATION: 3

3 SPECIFIER AND WITNESS GUIDANCE 5

3.1 APPLICATION AND SCOPE 5

3.2 AIR LEAKAGE SPECIFICATION 5

4 TESTING AGENCY GUIDE..... 8

4.1 U.S. ARMY CORPS OF ENGINEERS (USACE) STANDARD FOR AIR LEAKAGE 8

4.2 USACE PROCEDURE..... 8

4.3 APPLICATION AND SCOPE..... 8

4.4 EQUIPMENT SELECTION..... 9

4.5 PRE-TEST INSPECTION..... 10

4.5.1 Record Set-up Conditions 10

4.5.2 Preparation of the Building 11

4.6 REPORTING OF RESULTS..... 12

4.7 LOCATING LEAKAGE SITES WITH PRESSURIZATION AND DEPRESSURIZATION 13

5 AIR LEAKAGE TEST FORM 14

6 AIR LEAKAGE TEST RESULTS 21

7 TECHNICAL JUSTIFICATION FOR DIFFERENCES WITH ASTM 22

7.1 DEVELOPMENT OF THIS STANDARD..... 22

7.2 OBSERVATIONS 23

7.3 CONCLUSIONS 24

7.3.1 General 24

7.3.2 Testing in Both Directions 24

7.3.3 Allowance to Test in One Direction Only 24

7.3.4 Summary of Deviations from the ASTM Standard 24

8 GLOSSARY AND ACRONYMS..... 26

8.1 GLOSSARY AND ACRONYMS..... 26

8.2 ACRONYMS AND ABBREVIATIONS 27

1 Introduction

The 2005 Energy Policy Act requires that Federal facilities be built to achieve at least 30 percent energy savings over the 2004 American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 90.1-2004. The U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) of the U.S. Army Corps of Engineers (USACE), in collaboration with Headquarters, USACE and centers of standardization for respective building types, the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL), and the ad hoc ASHRAE Military Technology Group has developed design guides to help U.S. Department of Defense (DOD) facilities achieve at least 30 percent energy savings over a baseline built to the minimum requirements of the ASHRAE Standard 90.1-2004 for new buildings to be constructed under the Military Transformation Program.

The design guides were completed in 2007 and 2008, and pertain to building types that include barracks ("Unaccompanied Enlisted Personnel Housing," or UEPH), trainee barracks, administrative buildings (e.g., a battalion headquarters, a company operation facility), a maintenance facility, a dining facility, a child development center, and an Army reserve center.

Among the major factors contributing to mold prevention and reduced energy use in all climate zones is air leakage through the building envelope. Over the past several years, ERDC-CERL has conducted building envelope leakage tests on existing facilities to gain a better understanding of the general leakiness of Army buildings, and to analyze the effect of increased air tightness on building energy consumption, and to develop air tightness criteria and performance requirements to include in design/construction strategies.

Based on the results of these studies USACE set a requirement that all new buildings and buildings undergoing major renovation shall pass an air leakage test, the results of which must be less than or equal to 0.25 CFM/sq ft of exterior envelope at 0.3 in. of water gage (75 Pa) pressure difference. The test is to be performed as outlined in the protocol developed by ERDC-CERL together with industrial partners. Depending on the climate, the total building energy cost savings due to improved building air tightness can range from 5 to 25 percent.

Since introduction of the requirements to air barrier and a maximum allowable air leakage rate, several Army buildings were constructed and tested for air tightness. Some of them were proven to have an air leakage rate between 0.16 and 0.25 CFM/sq ft at a pressure difference of 0.3 inches of water gage (75Pa). Few buildings have to be sealed and re-tested to meet these requirements. This experience has shown that, when buildings are designed and constructed with attention to details, they can meet U.S. Army requirements for air tightness with only a minimal cost increase (due primarily for development of architectural details and testing).

2 USACE Requirements For Building Air Tightness

The following sections outline USACE requirements for building air tightness and building air leakage testing for new Army construction:

2.1 Building Air Tightness Requirement

Design and construct the building envelopes of office buildings, office portions of mixed office and open space (e.g., company operations facilities), dining, barracks and instructional/training facilities with a continuous air barrier to control air leakage into (or out of) the conditioned space. Clearly identify all air barrier components of each envelope assembly on construction documents and detail the joints, interconnections and penetrations of the air barrier components. Clearly identify the boundary limits of the building air barriers, and of the zone or zones to be tested for building air tightness on the drawings.

Trace a continuous plane of air tightness throughout the building envelope and make flexible and seal all moving joints. The air barrier material(s) must have an air permeance not to exceed 0.004 CFM/sq ft at 0.3 in. wg [0.02 L/s.m² @ 75 Pa] when tested in accordance with American Society for Testing and Materials (ASTM) E 2178. Join and seal the air barrier material of each assembly in a flexible manner to the air barrier material of adjacent assemblies, allowing for the relative movement of these assemblies and components.

Support the air barrier so as to withstand the maximum positive and negative air pressure to be placed on the building without displacement, or damage, and transfer the load to the structure. Seal all penetrations of the air barrier. If any unavoidable penetrations of the air barrier by electrical boxes or conduit, plumbing, and other assemblies are not air tight, make them air tight by sealing the assembly and the interface between the assembly and the air barrier or by extending the air barrier over the assembly. The air barrier must be durable to last the anticipated service life of the assembly. Do not install lighting fixtures with ventilation holes through the air barrier.

Provide a motorized damper in the closed position and connected to the fire alarm system to open on call and fail in the open position for any fixed open louvers such as at elevator shafts. Damper and control to close all ventilation or make-up air intakes and exhausts, atrium smoke exhausts and intakes, etc when leakage can occur during inactive periods. Compartmentalize garages under buildings by providing air-tight vestibules at building access points. Provide air-tight vestibules at building entrances with high traffic.

Compartmentalize spaces under negative pressure such as boiler rooms and provide make-up air for combustion.

2.2 Building Air Leakage Testing – Performance Requirement and Substation:

1. Submit the qualifications and experience of the testing entity for approval.
2. Demonstrate performance of the continuous air barrier for the building envelope by the following tests:
 - a. Test the completed building and demonstrate that the air leakage rate of the building envelope does not exceed 0.25CFM/sq ft at a pressure differential of 0.3 in. wag (75 Pa) in accordance with ASTM E- 779 (2003) or E- 1827-96 (2002). Accomplish tests using BOTH pressurization and depressurization. Divide the average measured air leakage flow rate in both directions in CFM @ 0.3 in. wag (L/s @ 75 Pa) by the surface area of the envelope enclosed by the continuous air barrier of the building, including roof or ceiling, walls and floor to produce the air leakage rate in CFM/sq ft @ 0.3 in. wag (L/s.m² @ 75 Pa). Do not test the building until verifying that the continuous air barrier is in place and installed without failures in accordance with installation instructions so that repairs to the continuous air barrier, if needed to comply with the required air leakage rate, can be done in a timely manner.
 - b. Test the completed building using Infrared Thermography testing. Use infrared cameras with a resolution of 0.1 °C or better. Perform testing on the building envelope in accordance with International Organization for Standardization (ISO) 6781:1983 and ASTM C1060-90(1997). Determine air leakage pathways using ASTM E 1186-03 Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier

Systems, and perform corrective work as necessary to achieve the whole building air leakage rate specified in (a.) above.

- c. Notify the Government at least 3 working days before the tests to provide the Government the opportunity to witness the tests. Provide the Government written test results confirming the results of all tests.

Existing buildings undergoing major renovations (especially the ones located in cold or hot and humid climates) shall be sealed to the same standard as newly constructed ones.

3 Specifier and Witness Guidance

3.1 Application and Scope

Use this Guide to gain a general understanding of the air leakage test, how it should be specified, and how to monitor whether the air leakage test has been properly performed. This air leakage test specification and the required pass/fail result must be applied to the entire exterior enclosure area as a single entity. See the included glossary (p 26) for definitions. In many circumstances, it is useful (but not currently required) to isolate components such as individual walls or floors to diagnose more closely the source of air leakage. In the future, individual components such as horizontal floor slabs may have their own more stringent requirements, but for now, only the air leakage of the entire exterior envelope is measured.

The architect or design engineer is responsible for defining the bounds of the enclosure and for calculating its surface area to be used in the results calculation. The surface area will include the floor, walls/fenestrations, and roof/ceiling. This enclosure is often the “exterior envelope” of the building, but does not always include all exterior walls. Of interest is the functional “air barrier” for the enclosure under test, which may not be the exterior envelope. For example, heating, ventilating, and air-conditioning (HVAC) rooms with large louvers open to outdoors, laundry rooms with dampers opening to outdoors, and loading docks with overhead coiling may be outside the air barrier enclosure if the design dictates such. This would force their interior walls to be insulated and air sealed to the same standard as other parts of the enclosure that face the outdoors.

The boundary of the air barrier must be clearly defined in the project drawings. Once properly considered by the design professional, the calculated surface area of the air barrier should be indicated on the design drawings.

For buildings where doorways from each apartment, office, meeting room, or other area that open from a common hallway or zone and not at the air barrier boundary, the entire building air barrier system must be tested as a whole.

For buildings where doorways of each apartment/office/room lead to the outdoors (i.e., where there is no direct interior connection between all the rooms), each apartment/office/room must be tested individually. Walls abutting adjacent apartments are to be treated as part of the envelope in spite of the fact that an argument can be made that leakage of the adjacent walls would be to another conditioned apartment and could therefore be ignored. To allow for efficient testing, common walls will be treated as part of the total envelope for the apartment and each apartment must pass the criteria. In multi-unit apartments, each style of apartment must be tested, including all corner rooms, and at least 20 percent of all other apartments must be tested.

Buildings over 500,000 sq ft. of envelope area may require special test techniques not covered in this protocol. The building may have to be broken up into zones separated using boundary pressure neutralization techniques or by the erection of temporary walls. In other cases, the use of the building HVAC or large truck mounted fans may be required to establish useful test pressures. These special techniques will require a higher level of experience and engineering to establish useful results. It is up to the specifier to establish conformance criteria and test procedures for these unique buildings. The Canadian General Standards Board (CGSB) standard CAN/CGSB-149.15, *“Determination of the Overall Envelope Airtightness of Buildings by Fan Pressurization Method Using the Building’s Air Handling Systems”* could be referenced by the specifier and used by the testing agency. However, the importance of air tightness should not be lost on buildings with enclosures over 500,000 sq ft.

3.2 Air Leakage Specification

The air leakage test specification could be written as follows:

The air leakage test must be performed in accordance with ASTM E- 779 with the following additions and exceptions shown below.

The test consists of measuring the flow rates required to establish a minimum of 12 positive and 12 negative building pressures. The lowest test pressure shall be 25 Pa; the highest test pressure shall be 75 Pa; and there must be at least 25 Pa difference between the lowest and highest test pressures. The test pressure must be measured in a representative location such that pressures in the extremities of the enclosure can be shown to not exceed $\nabla 10\%$ of the measured test pressure. At least 12 bias pressure readings must be taken across the envelope and averaged over at least 20 seconds each before and after the flow rate measurements. None of the bias pressure readings must exceed 30 percent of the minimum test pressure when testing in both directions. Where it can be shown that it is impossible to test in both directions, then the building may be tested in the positive direction only, provided the bias pressure does not exceed 10% of the minimum test pressure.

The mean value of the air leakage flow rate calculated from measured data at 0.3 in wg (75 Pa) must not exceed 0.25 cu ft/ minute per square foot of envelope area (0.25 CFM₇₅/ft²) and the upper confidence limit as defined by ASTM E-779 must not exceed (0.27 CFM₇₅/ft²) or the upper confidence limit must not exceed (0.25 CFM₇₅/ft²). Measurements must be referenced at standard conditions of 14.696 psi (101.325 KPa) and 68F (20°C). The envelope area is to be supplied and/or confirmed by the architect of record (AOR).

Additional information for the specifier

The Testing Agency Guide provides detailed information as to exactly how the test must be performed. The Air Leakage Test Form details the exact procedure that the testing agency followed. A completed test must consist of all pages of the Air Leakage Test Form with required attachments plus a seventh page titled Air Leakage Test Results, upon which the testing agency must make a pass or fail declaration.

Of note to anyone specifying the air leakage test, or under the requirement of an air leakage test, is that:

1. The test is conducted with ventilation fans and exhaust fans turned off and the outdoor air inlets and exhaust outlets sealed (by dampers or masking). In some cases, recirculating air handlers may also need to be turned off. The contractor must provide a responsible HVAC technician with the authority to place the HVAC system in the correct mode for the pressure test. The testing agency must have unhindered access to mechanical rooms, air handlers, exhaust fans, and outdoor air and exhaust dampers.
2. Portable pressurization door fans manufactured for the purpose of pressure testing buildings often require significant electrical power (e.g., 20 amps) and may trip circuit breakers. The contractor must have someone on site with access to and the authority to reset circuit breakers or must have access and authority granted to them.
3. Airflow and enclosure pressure differences are drastically affected when exterior doors or windows are opened. At the time of the test, if subcontractors are still working in the building, the contractor must ensure that all windows in the bounding enclosure are kept closed. Entry and exit through doors in the test enclosure must be eliminated during the test. Data collected while the pressures and flows are affected by a door opening and closing must be discarded.
4. Portable fan pressurization doors are placed in doors or windows in the bounding enclosure. The testing agency must have access to these locations, be able to open them, and to remove closure hardware that interferes with equipment set-up.
5. The contractor shall ensure that no sub-contractors are working in the area of the fan pressurization test equipment. During pressurization tests, air will be blown into the building at high enough velocity that it will cause debris, dust, and litter to become air borne. When exhausting nearby debris and litter may be drawn to the fan guards or become entangled in fan blades where it can block airflow and result in erroneous measurements.
6. The fan pressurization test to determine final compliance with the airtightness requirement shall be conducted when all components of the air barrier system have been installed and inspected, and have passed any

intermediate testing procedures as detailed in the construction drawings and specifications. The test may be conducted before finishes that are not part of the air barrier system have been installed. For example, if suspended ceiling tile, interior gypsum board, or cladding systems are not part of the air barrier system, the test may be conducted before they are installed.

7. The testing agency is required to perform a diagnostic evaluation in accordance with ASTM E1186, whether the building achieves the air tightness requirement or not. The diagnostic evaluation will assist the contractor and responsible parties in identifying and eliminating air leakage so the building meets the requirement upon re-testing. The testing results will also be expressed in terms of the Equivalent Leakage Area (EqLA) at 75 Pa. The EqLA is the equivalent area of a flat plate that leaks the same amount as the building envelope at 75 Pa. This information helps those responsible for further sealing the envelope know the approximate size of total hole area they should be seeking. Air leaks can consist of many small cracks, or a few very large openings or a combination of both. It is not unusual for large buildings to have a leakage area of up to 100 sq ft. It is also common for air sealing efforts to be focused on the small cracks while large holes that are a major contributor to failing the test, go unnoticed. Even if the building achieves the air tightness requirement, a diagnostic evaluation should be conducted to help the construction team identify additional areas of leakage that could be sealed on the current building or similar future buildings.

4 Testing Agency Guide

4.1 U.S. Army Corps of Engineers (USACE) standard for air leakage

The USACE requires all new buildings to pass an air leakage test where the results are less than or equal to 0.25 CFM/sq ft of exterior envelope at 75 Pa pressure at standard conditions.

4.2 USACE Procedure

The following sections provide useful background information that will give the testing agency more information so that they can more easily understand the step-by-step approach in the Air Leakage Test Form and the Air Leakage Test Form Guide. This test protocol was developed by the U.S. Army Corps of Engineers with assistance from the private industry using ASTM E- 779-03 as a basis. This protocol includes modifications and adjustments needed to account for the potential for bias pressures (due to wind and stack) that are found in high-rise buildings and unobstructed environments, and to strike a balance between accuracy, repeatability and ease of use with a variety of test equipment, test methods, and testing agencies. The section titled “Technical Justification for Differences with ASTM” (p 22) documents the main deviations from ASTM and the reasons why such deviations may occur.

4.3 Application and Scope

See the “Application and Scope” under the Specifier’s Guidance section.

The four-story building shown in Figure 1 (top left) has an enclosure that is described by the shape (bottom left top right), and that is accessed by an exterior stairway with no direct interior connection between floors. It therefore must be tested with multiple door fans simultaneously to measure the total enclosure leakage (top right bottom left). Note that a variety of fan setups are allowed under this protocol as long as a single zone with uniform pressure differentials is achieved.

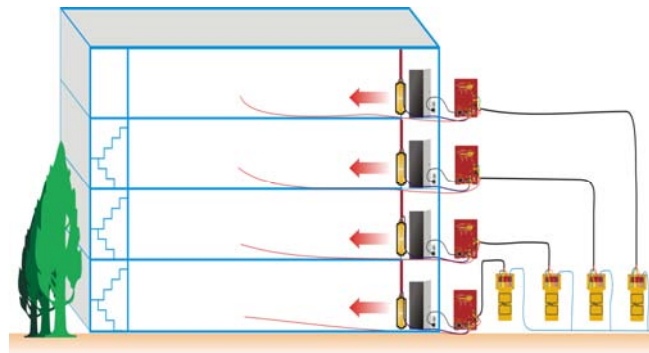
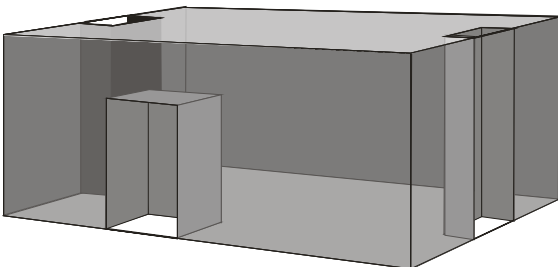


Figure 1. Example four-story building.

In buildings where individual apartments have doors to the outside (Figure 2, top left), the test must be performed on an individual apartment with the adjacent apartments open to outdoors. Perform door fan tests on all corner apartments plus a random 20 percent of those remaining. If they all pass then it can be assumed the rest of the apartments would also pass. Should any one apartment fail, an additional apartment must be added for each failure to the test until at least 90 percent of the tested units pass.

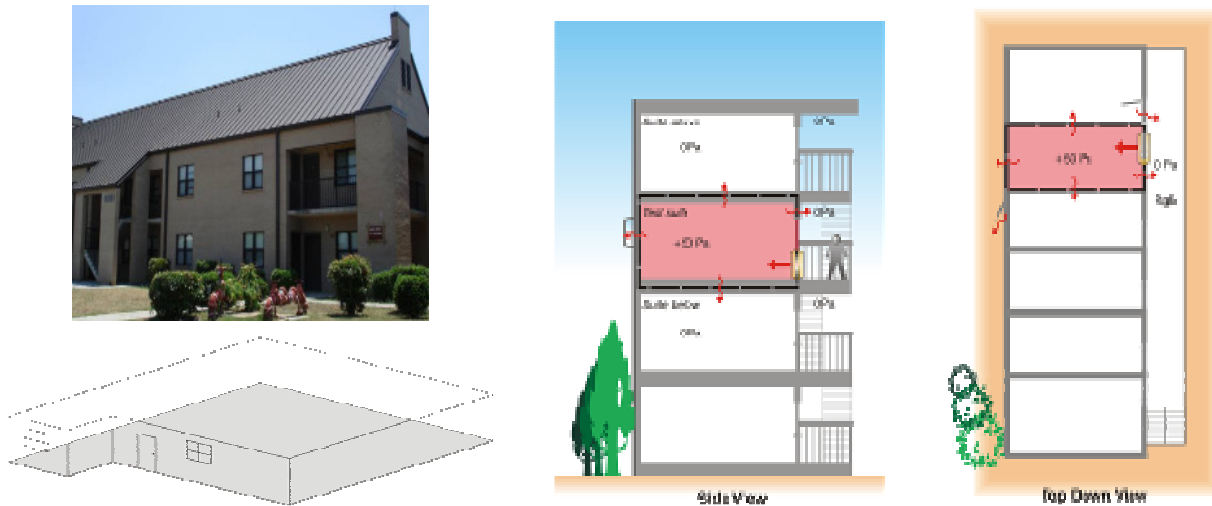


Figure 2. Example building where individual apartments have doors to the outside

4.4 Equipment Selection

Since a passing building requires the envelope to attain a leakage rate of 0.25 CFM/sq ft of envelope or less, multiply the envelope square footage that will be tested by 0.25 to get the approximate “passing” CFM needed at a 75 Pa pressure. Using the fan equipment manufacturer’s literature, you can select the amount of airflow-producing equipment needed to perform the test. Portable fans that can test in both positive and negative directions must be used unless it can be shown that it is impossible to do so. The testing agency must have sufficient airflow-producing equipment to achieve at least 100 percent of the required passing CFM under the 0.25 requirement.

For example, if the building had 100,000 sq ft of envelope area, then it would require $100,000 \times 0.25 = 25,000$ CFM to be supplied by the testing agency. This generally requires the simultaneous operation of multiple portable fans and pressure monitoring equipment strategically placed throughout the building. If the specifications call for an air leakage requirement that is relaxed to a greater leakage rate such as 0.75 CFM/sq ft for special buildings (i.e., storage facilities with overhead coiling doors), then the testing agency should use the 0.25 value as a minimum fan capacity required for the test. Building HVAC systems may be used to measure envelope leakage in some cases where a proficient testing agency is capable of measuring air flows through outdoor air and exhaust ventilation equipment using:

- Pitot tube or hot wire anemometer traverse.
- Pressure compensated shrouds (which work well on rooftop exhaust units, and which are very accurate because they include air from duct leakage as well as through grilles).
- Tracer methods for measuring airflows in ducts (ASTM 2029 Volumetric and Mass Flow Rate Measurement in a Duct Using Tracer Gas Dilution). NOTE: Tracer decay, constant injection and constant concentration methods for estimating total ventilation rate of the test zone itself are prohibited.
- Outdoor air flow stations may be used if one of the above methods is used to check accuracy at least on air flow for each station, or if the design of the HVAC system specifically placed outdoor air flow stations in good measurement locations that are field verified.

For whole building tests on buildings with air handling systems that have been designed to provide accurate outdoor airflow stations or for very large buildings, with over 500,000 sq ft of envelope, this may be the practical option.

The standard CAN/CGSB-149.15, *Determination of the Overall Envelope Airtightness of Buildings by Fan Pressurization Method Using the Building's Air Handling Systems* could be referenced and used by the testing agency. In the hands of experienced personnel, reasonable results may be achieved, but note that accuracies have been no better than ± 20 percent when 75 Pa was achieved.

It may be possible to isolate and test individual floors for buildings in excess of four stories, if the testing agency's equipment is not capable of achieving a full building uniform pressure due to the geometry of the interior partitions and limited shaft areas. However, the floor-by-floor method requires exceptional preparation and knowledge of airflow characteristics within chases, shafts, and wall cavities, in addition to maintaining an identical or balanced pressure at the floors above and below. Refer to the ASHRAE study, *Protocol for Field Testing of Tall Buildings to Determine Envelope Air Leakage Rate 935-RP* (Bahnfleth 1998) for additional information on the floor-by-floor method of testing. It is recommended that the whole building achieve a uniform pressure to avoid the uncertainty inherent in the floor-by-floor method, but this protocol does not prohibit the application of the floor-by-floor method as an option for buildings greater than four stories in height.

Pressure gauges must be digital and accurate to within ± 1 percent of reading or ± 0.25 Pa, whichever is greater, and must have adjustable time averaging to compensate for wind. Calibrated fans must be accurate to within ± 5 percent of the flow reading. Sufficient tubing must be available so that all gauges used can be manifolded together and referenced to the same outdoor pressure. These tubes will be connected to the negative port of all gauges. Tubing must also be available to run from the center of each separate test zone to the positive port of a gauge.

A minimum of one exterior pressure monitoring station is required. The testing agency is allowed to use additional exterior pressure monitoring stations, especially if bias pressures exceed the values stipulated in Section 4.5 of the Air Leakage Test Form.

The pressure difference between interior zones shall be monitored to determine whether pressure differences between interior locations are within 10 percent of the indoor-outdoor pressure difference during all tests or not. If they are not, then adjustments to test set-up shall be made until they are within 10 percent. Interior pressure difference measurements shall be referenced to a single interior zone that is unaffected by velocity pressure created by test equipment. Thus, at an average 75 Pascal pressure difference across the enclosure, the difference between the highest and lowest interior pressure difference measurements should be within 15 Pascals of each other. The number of indoor pressure difference measurements required depends on the number of interior zones separated by bottle necks that could create significant pressure drops (e.g., doorways and stairwells).

4.5 Pre-Test Inspection

A pre-test inspection must be performed to determine whether there is something that would prevent the test from being completed. Check local weather forecasts for rain or strong winds before travelling to the test site. Ensure that the test equipment has arrived at the test site on time, and that it is in operable condition. The operation of the equipment is the simplest part of the test, whereas preparing the building is the most complex, takes the most time, and is the most likely factor to prevent the testing agency from completing the test.

4.5.1 Record Set-up Conditions

Accurately record the exact set up conditions. Pictures should be taken of representative setup conditions and should be attached to the final report. The intent of this protocol is to ensure buildings are set-up and prepared in an identical manner so the tests are repeatable. The testing agency is responsible to ensure the building is properly prepared and maintained throughout the test, but the contractor typically performs the actual preparation labor described below.

4.5.2 Preparation of the Building

Seal or otherwise effectively isolate all “intentional” holes in the building enclosure. This includes air intake or exhaust louvers, make-up air intakes, pressure relief dampers or louvers, dryer and exhaust vent dampers and any other intentional hole that is not included in the air barrier design or construction. Intentional openings can be sealed by using an air-tight film or by motorized or manual dampers held in the closed position.

NOTE: Exterior windows and doors (fenestrations) are not intentional openings. Fenestrations are included in the air barrier test boundary. Exterior windows and doors shall be in the closed and locked position only; no additional films or additional means of isolation at fenestrations is allowed.

Ensure that all plumbing traps are filled with water.

The HVAC system must be shut down or disabled for the duration of the test. If the HVAC system activates during the test, additional air movement across the enclosure is introduced and is not measured by the agency, resulting in inaccurate data.

All interior doors that access the building enclosure (roof, walls and fenestrations, floor) must be held open during the test to create a single uniform zone. If the door services only an interior room such as a storage closet, it is allowed to remain closed only if a dropped ceiling plenum is present above and it does not access an air barrier boundary. If doorways cannot be opened and the volume on the other side of the door is considered to be within the envelope, then the pressure across that doorway must be measured with the door fan running to ensure that the pressure on the other side of the door, as measured with an under door probe, is within $\pm 10\%$ of the average building pressure.

Buildings with a dropped ceiling plenum must have tiles removed at a rate of one per every 500 sq ft. Additional tiles may be removed at the discretion of the testing agency so a uniform pressure distribution in the plenum space is achieved.

Combustion equipment must be disabled or be in the “pilot” position.

If the test zone is within a larger building enclosure such as a Tactical Equipment Maintenance Facility or Company Operations Facility, the areas outside of the test zone must be at ambient (outdoor) conditions. This can be achieved by open man-doors or overhead coiling doors in the open position.

Optional: Set-up the door fan and run preliminary test

If using door fans to pressurize the air barrier, perform a test with only one door fan. Occasionally, no additional testing will be required, as a preliminary test can help determine the following:

1. The quantity of additional door fans needed to achieve the desired test pressure.
2. A rough estimate as to whether the enclosure could pass, which may force the testing agency to spend more time investigating enclosure problems, instead of using time to verify an obvious failing enclosure.

For the preliminary test:

1. Record interior and exterior weather conditions
2. Record average and maximum wind speed and direction at least 5-feet off the ground and 25-feet away from the building in the direction of the wind.
3. Record interior and exterior temperatures before and after the test.
4. Record site elevation in feet above sea level.
5. Perform a multi-point test in both directions from at least + 25 to + 50 Pa, then - 25 to - 50 Pa.

Because this test is performed by pressurizing and depressurizing the air barrier envelope, bias pressure effects are minimized, yielding more accurate results. This is the preferred test method since it is not only more tolerant of test conditions, but also gives a more accurate representation of the envelope leakage under ambient conditions, where pressures can be either positive or negative in direction. Bias pressures may be up to 30 percent of the lowest test pressure, allowing this method to be used in a wider range of weather conditions. If fan power is sufficient, then

testing up to 75 Pa would be even more accurate and would allow tests to be completed where bias pressures were higher.

The testing agency must achieve at least 50 Pa, but there is no requirement that it must achieve a maximum pressure of 75 Pa. The agency is encouraged to achieve the highest building pressure possible, but should not exceed 75 Pa.

It is noted that some buildings will have air barrier systems that have not been properly designed and/or installed, resulting in the maximum building pressure being less than 50 Pa. Although the building does not meet the air leakage requirement of 0.25 CFM/sq ft, the testing agency must still perform a multi-point test in general accordance with this protocol so an approximate air leakage value can be provided to the prime contractor. This will allow them to estimate the magnitude of the repairs necessary to meet the air leakage requirement.

4.6 Reporting of Results

The data collected during the multi-point tests will be corrected for standard conditions and used to determine the air leakage coefficient, C , and the pressure exponent, n , in accordance with ASTM E779-03, from:

$$CFM = C * \Delta P^n$$

In general, the C and n values are obtained by plotting the data in log-linearized fashion to obtain a curve fit that will produce the required coefficients. The testing agency must use a minimum of 12 data points from each test, but is not limited to the maximum number of data points taken during the test. It is recommended to take additional data points so in the analysis the “outliers” can be omitted from the calculation procedure. Outliers are most frequently caused by wind gusts, changes in wind direction at the time that data pair was recorded, among other reasons.

One flow rate must be calculated for both the pressurization and depressurization tests at a ΔP of 75Pa (CFM@75Pa). The average of those CFM values will be divided by the enclosure area given in the project drawings to determine the normalized air leakage rate. This average value will be used as the basis for determination if the building meets or does not meet the requirement of 0.25 CFM/sq ft_{envelope} @75-Pa. The value is to be rounded to the nearest hundredth. Therefore, a value of 0.255CFM/sq ft does not meet the USACE requirement.

In addition to reporting the normalized air leakage as CFM/sq ft_{envelope} @75Pa, the agency is also required to report the correlation coefficient (r^2) and 95 percent Confidence Intervals (95%CI) to determine the accuracy of the data collected and the quality of the relationship between flow and pressure that was established during the test. The 95%CI should be calculated in strict accordance with the methodology contained in ASTM E779-03 and the r^2 value can be obtained by data analysis of the plotted data.

In general, a narrower 95%CI to the mean value and higher r^2 value indicates a clear relationship for the building's air leakage characteristics was established. For the collected data to be statistically significant, the 95%CI must not exceed $\nabla 0.02$ for mean values of 0.25 or less, which equates to approximately 8 percent. For example, if the calculated mean value is 0.25 and the 95%CI is shown to be 0.23 to 0.27, the test data is statistically significant. However, if the mean value is 0.25 and the 95%CI is 0.16 to 0.33, this exceeds 0.02 and indicates that the data is not statistically significant, and that a clear relationship between flow and pressure was not established during the test; the test must be repeated. In cases where the 95%CI exceeds $\nabla 0.02$, but the upper limit is 0.25 or less, the test would be considered a pass in spite of the statistical insignificance because there is a strong likelihood that the building passes the requirement. Likewise, the r^2 value must be above 0.98 for the data to be statistically significant. Test data should have correlations above 0.99.

Similarly, the pressure exponent, n , will also provide some insight as to the accuracy of the test and relative tightness of the building enclosure. Exponent values less than 0.5 or greater than 1.0 in theory indicate a bad test, but in practice, tests outside the range of 0.45 to 0.8 would generally indicate an inaccurate test or calculation methodology. The reason comes down to basic fluid dynamics and the characteristics of developing airflow through orifices, which is too lengthy to discuss within this protocol. Except for very rare circumstances, n values should not take on values less than 0.45 or greater than 0.8. If the n value exceeds these boundaries, the test must be repeated. In general, an n value closer to 0.5 indicates large holes that are much shorter in length than they are wide, where an

n value above 0.65 indicates the hole characteristics that are smaller cracks or holes that are much longer than they are wide. Most “tight” residential homes exhibit an n value of 0.60 to 0.65, where larger buildings will likely have an n value slightly less.

The testing agency is required to produce the data used in the analysis and results in tabular and graphical form, including the curve fitted coefficients and correlation coefficient.

Several common conditions that will cause test results to be very low are:

1. Interior pressure monitoring stations are placed too close to direct air flow that is typically produced by the test fans.
2. Usually tests are conducted with the fan orifice fully open, allowing maximum airflow. For testing smaller envelopes that require smaller test flows, a flow restriction device such as a plug or plastic ring can be installed on the fan. When limiting the fan air flow, the gage manufacturer requires that the digital gage's configuration be adjusted. If the gauge is incorrectly set on a lower range than the fan, then the measured flow will be much lower than the actual flow.
3. Interior doors have been left closed.
4. Exterior envelope is very tightly sealed.

Several common conditions will cause results to be very high are:

1. Intentional openings have not been properly sealed or have opened during the test (i.e., pressure relief dampers, plumbing traps).
2. Windows or exterior doors are left open.
3. HVAC equipment is not properly disabled.
4. If the gauge is set on a higher range than the fan, then the measured flows will be much higher than the actual flow.
5. It is possible the building contains significant holes in the air barrier enclosure and the high readings are simply an indication of the performance of the building.

4.7 Locating Leakage Sites with Pressurization and Depressurization

If the building fails the test, it is important to determine the source of the air leakage. It is also beneficial for the design-build team to understand the locations and details that are susceptible to leakage, even if the building as a whole passes the test. The testing agency is required to perform a diagnostic evaluation in accordance with ASTM E1186. The testing agency can use additional methods to discover leaks.

Neutral buoyancy smoke, theatrical smoke and infrared (IR) are effective means to find leakage sites. When testing equipment pressurizes the enclosure, air leaks can be seen from outdoors (provided exterior walls have not been heated by radiation from the sun) using infrared thermography or large scale smoke generation. When testing equipment depressurizes the enclosure, air leaks can be observed from the inside using infrared thermography and smoke generation. The manipulation of the HVAC system is required to perform an effective infrared thermography scan to achieve a temperature differential of at least 10 °F.

An Infrared Training Center (ITC) Level I Certified Infrared Thermographer is required by this protocol to perform the infrared diagnostic evaluation. Otherwise, the agency must submit the qualifications of the infrared thermographer, who must have at least 5 years experience in building science applications with infrared thermography. Anomalies such as thermal bridges and emissivity reflections are commonly mistaken as air leakage. The testing agency must employ thermographers with experience in building enclosures and building physics to achieve accurate diagnoses and to make effective recommendations to the design-build contractor in the event of failure and repair.

In general, when locating leaks, the airflow equipment should be adjusted to establish a minimum of +25 Pa pressure differential to use smoke and infrared while viewing the building from outdoors. A pressure differential of -25 Pa should be used for using infrared from the interior. Additional information is required in the diagnostic evaluation in accordance with ASTM E1186.

5 Air Leakage Test Form

For buildings constructed in compliance with the U.S. Army Corps of Engineers Air Leakage Protocol

Building name:

Building address:
Prime Contractor: Contact:

Testing agency:
Address:
Testing Agency Contact: Phone:
Lead on-site personnel: Phone:
Test date:

Witnesses:		
Name	Organization	Telephone/email

INSERT PHOTOGRAPH OF SUBJECT BUILDING

Testing agency to provide a Compact Disk (CD) with digital photographs of subject building, setup, test procedures, and diagnostic evaluation.

Step	Description	Result
1	Enclosure Area: Record the total exterior enclosure surface area including walls, floor and ceiling from design plans as supplied by the Architect of Record (AOR). Verify the dimensions used by the AOR in the calculations match as-built conditions and that the arithmetic was performed correctly.	sq ft
NOTE: Testing agency to attach a description of the building characteristics, including intended use, wall, roof, and floor construction, fenestrations, HVAC system, air barrier system, and any additional information that may be relevant to the air leakage test.		

2	Set Up Checklist				
2.1	Confirm HVAC shutdown/disabling.		2.2	Confirm all dampers in the enclosure perimeter are closed and/or isolated.	
2.3	Confirm exhaust fans & dryers are off and isolated at the enclosure level.		2.4	Confirm combustion appliances are on pilot or are disabled.	
2.5	Confirm all air inlets at the enclosure perimeter are sealed or isolated.		2.6	Confirm all interior doors are propped open.	
2.7	Confirm all air outlets at the enclosure perimeter are sealed or isolated.		2.8	Note rain or snow conditions that may be affecting leakage of walls.	
2.9	Confirm exterior doors and windows are closed and latched.		2.10	Confirm ambient conditions provided are outside of air barrier envelope.	
2.11	Confirm all plumbing traps are filled with water.		2.12	Confirm dropped ceiling tiles are removed at specified rate.	
2.14	Confirm uniform interior pressure distribution by establishing at least 30 Pa and using a minimum of four pressure monitoring stations with one common exterior pressure monitoring station. Measure pressures at the four interior stations to ensure the interior pressure is within $\pm 10\%$ of target value. List interior stations and pressures measured: Interior Station Locations: _____ _____ _____ _____ _____ Pressure: ____ Pa ____ Pa ____ Pa ____ Pa				

2.15	Describer the approximate locations of the exterior pressure monitoring stations and whether the stations will be manually averaged or a manifold used. Exterior Station Locations: Means of averaging: _____
Additional Set up notes: 	

3	Testing equipment used			
Gage 1	Model:	Serial #:	Accuracy:	Calibration Date:
Gage 2	Model:	Serial #:	Accuracy:	Calibration Date:
Gage 3	Model:	Serial #:	Accuracy:	Calibration Date:
Gage 4	Model:	Serial #:	Accuracy:	Calibration Date:
The gage must have an accuracy of $\pm 1\%$ or 0.5 Pa, whichever is greater and must have had its calibration checked against a National Institute of Standards and Technology (formerly National Bureau of Standards, or NIST) traceable standard within 2 years.				
Fan 1	Model:	Serial #:	Accuracy:	Calibration Date:
Fan 2	Model:	Serial #:	Accuracy:	Calibration Date:
Fan 3	Model:	Serial #:	Accuracy:	Calibration Date:
Fan 4	Model:	Serial #:	Accuracy:	Calibration Date:
The fan must have an air flow measurement accuracy of ± 5 percent of the measured flow and must have had its calibration checked against a NIST traceable standard within 5 years.				
Infrared Camera	Model:	Serial #:	Accuracy:	Calibration Date:
The infrared camera must have a sensitivity of $\nabla 0.1^\circ\text{C}$ and must have been calibrated within 1 year of the test date.				
Attach calibration certificates for all equipment listed above to air leakage test form. If additional fans or gauges are used during the test, attach calibration certificates.				

4	Perform a multipoint pressurization door fan test														
4.1	Record indoor and outdoor temperatures before and after the test.	Indoor Pre-Test				Indoor Post-Test									
		Outdoor Pre-Test:				Outdoor Post-Test:									
4.2	Record wind speed and direction	Average mph				Direction									
4.3	Record elevation of building above sea level.									ft					
4.4	Record 12 Bias Pressure Test Points where each test point consists of at least 12 readings taken over at least 10 seconds. Show positive and negative signs.														
Bias Pressure Test Points		1	2	3	4	5	6	7	8	9	0	11	12		
		Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa		
4.4.1	Record the magnitude of the greatest Bias Pressure Test Point .										Pa				
4.4.2	Record the amount of time taken to collect each Bias Pressure Test Point .										sec				
4.5	If this value is 15 Pa or less, proceed with step 4.6. If greater than 15 Pa, repeat step 4.3 over a longer time period.														
<p>Pressurization test. Adjust the door fan speed to establish a series of a minimum of 12 equally spaced Building Pressure Test Points where each Test Point is an accumulation of at least 10 readings taken over a time period that is at least double the time taken to collect Bias Pressure Test Points in 4.4.</p> <p>Testing in two directions: the minimum test pressure must be at least 25 Pa and must also be at least the absolute value of greatest Bias Pressure Test Point $\times 10/3 =$ _____ Pa. The maximum test pressure should be at least 25 Pa greater than the minimum test pressure. The testing agency is required to supply 100% of the estimated "passing" flow using $0.25 \text{ CFM/sq ft}_{\text{envelope}}$ to estimate the passing flow.</p>															
4.6	Record the actual Building Pressures (Pa) from one or more interior pressure monitoring stations and the exterior pressure station(s), averaged or manifolded, with corresponding Flows (CFM) for each fan.														
4.6.1	Attach to this test form the results of the pressure and flow readings taken during the test. Results should be provided in tabular and graphical form. Graph should include correlation coefficient (r^2) and plotted in log-linearized fashion. A minimum of 12 points must be provided, but the testing agency is allowed to take additional data points to assist in data analysis and increase the accuracy of the test. There is no limit to the number of data points taken during the test, but a minimum of 12 must reported for data analysis and results.														
4.7	Record the amount of time to be taken to collect each Building Pressure Test Point .										sec				

4.8	Record 12 Bias Pressure Test Points over the same time periods as step 4.4.												
Bias Pressure Test Points		1	2	3	4	5	6	7	8	9	10	11	12
		Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa
4.9	Calculate the Average Bias Pressure for all 24 Test Points taken in step 4.										Pa		
4.10	Subtract value in 4.9 from all pressure readings taken in 4.6. This is the total corrected building pressure used in the analysis. See step 6.												

5.	Perform a multipoint depressurization door fan test												
Testing in both directions is the preferred method, but if in section 4.6 if it was noted that the test was to be performed in only one direction, then step 5 can be omitted.													
5.1	Record indoor and outdoor temperatures before and after the test.						Indoor Pre-Test		Indoor Post-Test				
							Outdoor Pre-Test:		Outdoor Post-Test:				
5.2	Record wind speed and direction						Average mph		Direction				
5.3	Record elevation of building above sea level.										ft.		
5.4	Record 12 Bias Pressure Test Points where each test point consists of at least 10 readings taken over the time period determined in step 4.5. Show positive and negative signs.												
Bias Pressure Test Points		1	2	3	4	5	6	7	8	9	10	11	12
		Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa
5.4.1	Record the magnitude of the greatest Bias Pressure Test Point .										Pa		
5.4.2	Record the amount of time taken to collect each Bias Pressure Test Point .										sec		
Depressurization test. A pressurization test must already have been performed. Take depressurization test points at the same absolute values of Building Pressure as used in section 4.													
5.5	Record the actual Building Pressures (Pa) from one or more interior pressure monitoring station and a minimum of four exterior pressure stations, averaged or manifolded, with corresponding Flows (CFM) for each fan.												
5.5.1	Attach to this test form the results of the pressure and flow readings taken during the test. Results should be provided in tabular and graphical form. Graph should include correlation coefficient (r^2) and plotted in log-linearized fashion. A minimum of 12 points must be provided, but the testing agency is allowed to take additional data points to assist in data analysis and increase the accuracy of the test. There is no limit to the number of data points taken during the test, but a minimum of 12 must be used for data analysis and results.												
5.4	Record the amount of time taken to collect each Building Pressure Test Point .										sec		

5.7	Record 12 Bias Pressure Test Points in exactly the same fashion as step 4.4.												
Bias Pressure Test Points		1	2	3	4	5	6	7	8	9	10	11	12
		Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa
5.8	Calculate the Average Bias Pressure for all 24 Test Points taken in step 5.										Pa		
5.9	Subtract value in 5.8 from all pressure readings taken in 4.6. This is the total corrected building pressure used in the analysis. See step 6.												
6.	Calculate and Report Results												
Subtract the Average Bias Pressure from all Building Pressures to arrive at Corrected Building Pressure . Curve fit pressures and flows from the tables and calculate the following values in strict accordance with ASTM E779-03. Provide tabulated and graphical data as an attachment to this test form.													
Pressurization													
6.2	The air leakage coefficient C_p for										CFM/Pa ⁿ		
6.3	The exponent n_p for pressurization. (NOTE: if n_p is less than 0.45 or greater than 0.8, test data is invalid and test must be repeated.)												
6.4	CFM referenced to standard temperature and pressure (STP) at +75 Pa.										CFM		
6.5	CFM/sq ft of envelope at +75 Pa										CFM@75/sq ft		
6.6	The correlation coefficient, r^2 , of the curve fitted data with a minimum of 12 points. (NOTE: if r^2 is less than 0.98, test data is invalid and test must be repeated.)												
6.7	Calculate the 95% confidence interval at +75 Pa for test in pressurization. (NOTE: if the upper confidence interval exceeds 0.27 the test data is invalid and test must be repeated. If the upper confidence limit is 0.25 or more and the lower confidence limit is 0.04 lower, the test data is invalid and the test must be repeated.)										CFM@75/sq ft CFM@75/sq ft		
Depressurization													
6.8	The air leakage coefficient C_d for depressurization.										CFM/Pa ⁿ		
6.9	The exponent n_d for depressurization. (NOTE: if n_p is less than 0.45 or greater than 0.8, test data is invalid and test must be repeated.)												
6.10	Calculate CFM referenced to STP at -75 Pa.										CFM		
6.11	CFM/sq ft of envelope at -75 Pa										CFM@75/sq ft		
6.12	The correlation coefficient, r^2 , of the curve fitted data with a minimum of 12 points. (NOTE: if r^2 is less than 0.98, test data is invalid and test must be repeated.)												
6.13	Calculate the 95% confidence interval at +75 Pa for test in pressurization. (NOTE: if the upper confidence interval exceeds 0.27 the test data is invalid and test must be repeated. If the upper confidence limit is 0.25 or more and the lower confidence limit is 0.04 lower, the test data is invalid and the test must be repeated.)										CFM@75/sq ft CFM@75/sq ft		

	Both Pressurization and Depressurization	CFM
6.14	Calculate the average CFM/sq ft from 6.5 and 6.10	CFM@75/sq ft
6.15	Building passes if the value 6.14 is less than 0.25 CFM/sq ft at 75 Pa.	Pass/fail
6.16	For the purpose of visualizing the magnitude of the air leakage of the enclosure, calculate the equivalent leakage area in square feet at 75 Pa.	sq ft
7.	Perform a diagnostic evaluation in accordance with ASTM C1060 and ASTM E1186. Attach results of diagnostic evaluation to this test form.	

8.	Restore the building to pre-test conditions
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6 Air Leakage Test Results

Testing Agency Certified Compliance with U.S. Army Corps of Engineers air leakage protocol

1	The enclosure area was obtained from the architect of record and was checked on site for reasonableness.	Initial
2	Set up conditions were performed according to section 2 and all deviations and their impact noted.	initial
3	Test equipment used was in compliance respect to accuracy and calibration date.	Initial
4	The test procedure used was in compliance except as noted here.	initial
5	The calculations were done in strict accordance with ASTM E779-03 except as noted in the Protocol.	initial
6	Provide the value calculated in step 6.14.	CFM@75/sq ft
7	Building passes if the value in step 6.14 is less than 0.25 CFM/sq ft _{envelope} at 75 Pa.	Pass/fail
8	All accuracies, pressure limits and data correlations and confidence intervals are within the bounds specified in sections 4, 5 and 6 and all deviations are noted.	
9	Supporting documentation described in 1, 3, 4.6.1, 5.5.1, and 7 is attached to this test form, including all digital photographs of the building and test procedure.	initial

I hereby certify that the results above are in conformance with the U.S. Army Corps of Engineers protocol.

Testing Agency Name

Testing Agency Authorized Representative Signature

Testing Agency Authorized Representative Printed Name

Date

7 Technical Justification for Differences with ASTM

7.1 Development of this Standard

The development of this standard and the associated testing protocol considered virtually every standard in widespread use. Standards that played an important part in this development were:

- ASTM E779-03 “Standard Test Method for Determining Air Leakage Rate by Fan Pressurization”
- ASTM E1827-96 “Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door”
- The Canadian Building Code
- Various applicable ASHRAE standards
- Air Tightness Testing and Measurement Association (ATTMA) Technical Specification 1 (United Kingdom [UK])
- CGSB 149.10, Canadian air leakage standard.

Key differences among these standards are:

- Choice of test pressures (10 Pa, 50 Pa versus 75 Pa)
- Way of expressing results (EqLA, CFM50, ACH50, CFM/sq ft @ 75Pa)
- Necessity and method for accounting for bias pressures (called “zero flow pressures” for the pressure measured with zero flow going through the door fan).
- Necessity and method for accounting for additional parameters (barometric pressure, humidity, temperature, elevation).

Both ASTM standards were originally intended for the testing of residential detached housing. Under these standards, multiple test points are gathered from 10 Pa up to 60 Pa and results are expressed in CFM @ 50 Pa or air changes per hour (ACH) @ 50 Pa (where CFM @ 50 Pa is the flow rate, in CFM, required to depressurize the house to – 50 Pa). It is also referred to as “CFM at 50 Pa,” “CFM @ 50,” or simply “CFM50.” ACH @ 50 Pa is CFM50 divided by the house volume. It is also referred to as “Air Changes at 50 Pa” or “ACH50”). The other commonly required result is Effective Leakage Area (EfLA) at 4 Pa (which is not to be confused with EqLA).

Both ASHRAE and the Canadian Building Code use testing points up to 75 Pa and express their results in terms of flow per square foot of surface area at 75 Pa.

The preferred test method for this standard includes:

1. Multiple test points from 75 Pa to 25 Pa
2. Testing in both the pressurization and the depressurization directions
3. Taking a comprehensive bias pressure over a long time interval to determine the lowest possible test pressure and to provide a more accurate bias correction
4. Expressing results in terms of CFM @ 75 per sq ft of enclosure area

The higher test pressure of 75 Pa was chosen for this standard since larger buildings are subject to higher bias pressures from wind and stack effects. Since wind velocity increases with height above ground, higher pressures due to wind are experienced. As height doubles, the increased bias pressures experienced due to wind roughly double. Houses typically experience bias pressures of 2 to 5 Pa whereas larger buildings can experience 10 to 20 Pa. Taking results at higher pressures helps achieve a more consistent result. A 75 Pa test pressure is about as high a pressure as is practical without vastly increasing door fan power, which would substantially increase the risk of damage due to higher wind velocities and pressures, and which is about the maximum a well-hung suspended ceiling can withstand without tearing it down in depressurize mode or blowing the tiles out in pressurize mode.

A sensitivity analysis was done on the sixth floor of an office building. Data was gathered in no-wind conditions and in conditions with a 10 to 15 mph wind blowing. Six test points were taken per test except for tests in both directions where six points were taken in each direction. Results were measured in CFM at 75 Pa. Twenty-three tests were performed under low wind conditions and another 26 tests were performed under windy conditions. All low wind tests were averaged and that average was used as the true result. The deviation result shown was the average deviation from the true result.

Direction	Pressure range	No wind CFM75		Deviation (%)	Error range (%)
		Deviation (%)	Error range (%)		
Depressurize with Bias	-60 to -12.5 Pa	2	-2.5 to + 1.5	17	-24 to -10
Depressurize with Bias	-50 to -25 Pa	2	-2.5 to + 1.5	10	-13 to -6
Depressurize with Bias	-75 to -50 Pa	1.4	-2 to + 0.5	5.3	-7 to -3
Both Directions with Bias	∇75 to ∇50 Pa	1.1	-1.1 to + 1.5	4.9	-6 to -3
Both Directions without Bias	∇75 to ∇50 Pa	1.5	-1.8 to + 1.5	3	-6 to -1
Both Directions without Bias	∇50 to ∇25 Pa	1.5	-1.8 to + 1.9	4.9	-8 to -3

Direction	Pressure range	CFM75 in 2 to 4 mph wind, deviation %	CFM75 in 10 to 15 mph wind, deviation %
Depressurize	-60 to -12.5 Pa	2%	17%
	-50 to -25 Pa	2%	10%, 30%, 16%
	-75 to -50 Pa	1.4%	5.3%, 9%
Pressurize	+50 to +25 Pa	2%	9%, 15%
	+75 to +50 Pa	1%	3%, 6%, 5%
Both ways	∇50 to ∇25 Pa		11%, 10%
	∇75 to ∇50 Pa	1.1%	4%, 3%, 4.9%, 3%

7.2 Observations

1. Under windy conditions, the classic ASTM test procedure (measuring the before and after bias pressure and only testing in one direction from 60 to 12.5 Pa) produced the most unacceptable results. Variations in flow readings from 1 minute to the next, even with time averaging in place, varied as much as 25 percent for one reading.
2. If testing was to be completed in only one direction, reasonable results could be achieved by measuring the before and after bias pressures and testing at higher test pressures, from 75 to 50 Pa.
3. Testing in both directions and averaging the results always yielded results with less deviation than only testing in one direction.
4. Bias pressures taken with 30 second averaging would vary markedly from one sample to the next leading us to conclude that an even more rigorous method was required, such as 12 readings taken over at least 120 seconds.

7.3 Conclusions

7.3.1 General

1. The classic ASTM set of test points from 10 to 60 Pa was unacceptable under windy conditions.
2. The preferred test method is to test in both directions, from 50 to 75 Pa up to a maximum of 75 Pa. Allow for larger bias pressures by taking numerous readings to establish a test point over at least 10 seconds and then taking 12 test points in total. Then the door fan readings would be taken over a time period that is twice as long.
3. If testing in both directions is not possible due to the equipment characteristics, then pressurize only readings would be acceptable, but the test must be from 50 to 75 Pa.

ASTM encourages testing under ideal weather conditions of less than 4 mph wind and a temperature range of 41 to 95 F to keep bias pressures to a minimum, but these ideal conditions are seldom experienced in tall buildings due to their height or their specific environment, increasing the likelihood that the test will be canceled. A more robust procedure is required to handle bias pressures that allow buildings to be tested in virtually any weather conditions short of storms. ASTM makes small corrections for temperature, barometric pressure, and elevation that do not help much with overall accuracy, but give the impression of accuracy. The overriding source of accuracy and repeatability is due to bias pressure.

7.3.2 Testing in Both Directions

The preferred way to eliminate bias pressure problems is to test the building in both the pressurization and depressurization directions and average the results. Bias pressure errors are non linear and cannot be properly allowed for by merely subtracting the bias from the reading. Testing in both directions cancels out these errors very effectively thus tolerating much larger bias pressures, up to 30 percent of the lowest test pressure.

7.3.3 Allowance to Test in One Direction Only

Making allowances for testing in only one direction acknowledges that very large buildings may require truck- or trailer-mounted blower equipment or that they may require the use of the building HVAC system that logistically will not easily allow testing in both positive and negative directions. Because bias pressures will have a greater impact on single-direction tests, the maximum allowable bias pressure under these circumstances has been reduced to 10 percent of the lowest test pressure of 50 Pa in this case. On the other hand, the upper test pressure achieved must be at least 75 Pa. At these pressures, the bias pressure is somewhat masked by the higher test pressure and extrapolation is no longer an issue. Because buildings often leak more in one direction versus the other, testing in only one direction must be considered less accurate than testing in both directions.

The bias pressure in a 40-ft high building where the temperature was 0 °F outside and 68 °F inside and negligible wind for example, would be 10.5 Pa. This bias would typically be broken up into say +5 at the top and -5.5 at the bottom of the building. If bias pressure was a problem during the test the indoor temperature could be brought closer to the outdoor temperature by running door fan for about 5 minutes, which would be sufficient time to replace most of the indoor air with outdoor air, and thereby reduce the bias pressure somewhat.

7.3.4 Summary of Deviations from the ASTM Standard

All pressure tests shall comply with the requirements of ASTM E 779-03 with exceptions indicated in the table below.

ASTM E 779-03	U.S. Army CE Protocol	Reason for change
6.2.2 “accuracy of ∇ 5% of measured pressure.”	The gage must have an accuracy of ± 1 % or 0.5 Pa, whichever is greater and must have had its calibration checked against a NIST traceable standard within 2 years.	Modern gauges are typically much more accurate than the analog gauges that ASTM was written to accommodate and there is every reason to take advantage of the increased accuracy.
8.4 “If the product of the absolute value of the indoor/outdoor air temperature difference multiplied by the building height, gives a result greater than 1180 ft °F, do not perform the test, because the pressure difference induced by the stack effect is too large to allow accurate interpretation of the results.”	The protocol allows for a wider range of heights and temperatures by limiting bias pressure to 30% of the lowest test pressure when testing both ways and 10% when testing one way.	The ASTM requirement of 1180 ft °F would only permit four-story buildings (48 ft high) to be tested when the indoor/outdoor temperature difference was less than 25 °F, which would be impractical. The Protocol is both more stringent and more flexible due to the higher minimum test pressures that tolerate higher bias pressures. The ASTM requirement of 1180 ft °F produces a stack of about 4.2 Pa, which is 42% of the lowest 10 Pa test point whereas the Protocol permits a maximum bias pressure (wind and stack) of 30% of the lowest test pressure when testing both ways and 10% when testing one way. This results in a maximum allowable bias pressure of 7.5 to 15 Pa and 5 Pa for the Protocol.
8.5 “Preferred test conditions are wind speed of 0 to 2 m/s [0 to 4 mph] and an outside temperature from 5 to 35° C. [41 to 95° F].”	Preferred test condition superseded by requirement to keep bias pressure within limits.	The ASTM preference of wind speeds less than 4 mph and outside temperature range from 41 to 95°F would mean that the rescheduling of test would be required in about 50% of all cases. This is impractical and the more robust procedure in the protocol takes care of wind and temperature differences by accurately measuring bias pressures over a period of time and then requiring that the air leakage measurements are made over the same time period.
8.10 “.... Pressure difference shall be from 10 to 60 Pa...at least five data points...”	“Adjust the door fan speed to establish a series of 12 equally spaced Building Pressure Test Points where each Test Point is an accumulation of at least 10 readings taken over a time period that is at least double the time taken to collect Bias Pressure Test Points”	Because results are required at 75 Pa, taking data up to and including this point of interest vastly increases accuracy and repeatability. The Protocol is far more stringent than ASTM yet with modern equipment takes less effort than the old manual way of taking readings.
8.13 “For each test, collect data for both pressurization and de-pressurization.”	Testing in both directions is preferred. Testing from ∇ 75 Pa to ∇ 50 Pa is acceptable because buildings tend to leak slightly more under positive pressure.	Testing in both directions results in simpler and more repeatable tests. Tests with trailer mounted fans or the building's HVAC systems may only be possible in one direction and the protocol allows for then to be used.

8 Glossary and Acronyms

8.1 Glossary and Acronyms

Term	Definition
air tightness	Pertains to how free air leakage may be in an enclosure. In actual fact, measurements can only be made of air leakage rates not air tightness itself so one could think of these terms as being opposites. In spite of the confusion, the terms are used interchangeably.
air barrier	The air barrier defines the surface that separates the inside air from the outside air. Generally this should be an inner barrier such as sheet rock, which prevents air from moving through the insulation. The air barrier should be in contact with the insulation. The air barrier should not be outside the insulation.
air leakage	Pertains to how leaky an enclosure may be. See Air tightness.
average bias pressure	A series of 12 test pressure points that are averaged to produce one value.
baseline pressure	A method of reading or determining the background or bias pressure by having a digital gauge accumulate readings over an adjustable time period .
background pressure	See bias pressure.
bias pressure	This is defined as the pressure that exists when the enclosure has been prepared for the test, but before the fan pressurization system is activated. There is always some bias pressure due to stack, wind, flues and active HVAC systems. There are two components of bias pressure. A fixed static offset (usually due to stack or HVAC) and a fluctuating pressure (usually due to wind or elevator operation). In ASTM bias pressures are called “zero flow pressures” for the pressure measured with zero flow going through the door fan.
blower door	Commonly used term for a door fan, which means a calibrated fan capable of measuring air-flow. The door fan is temporarily mounted in doorway, hence the adjective “door” prefixing “fan.” Door fans do not use blowers. A blower more accurately describes an air moving device of the squirrel cage variety; hence the adjective “blower” does not normally apply to the bulk of door fans since they do not use a blower.
building envelope	See enclosure.
building enclosure	The boundary or air barrier separating the interior conditioned volume of a building from the outside environment. See enclosure.
CFM @ 50 Pa or CFM50	CFM @ 50 Pa is the flow rate, in CFM, required to depressurize the building to – 50 Pa.
ACH @ 50 Pa	ACH @ 50 Pa is CFM50 x 60 minutes/ hour, divided by the house volume. It is also referred to as “Air Changes at 50 Pa” or “ACH50.”
conditioned volumes	Any space maintained above 50 °F in winter and below 80 °F in summer.
door fan	A calibrated fan capable of measuring air-flow of that is temporarily mounted in a doorway. Door fan is more linguistically correct than the common term “blower door.” Since it is not a “door,” but rather a “fan” and since it does not use a “blower.” a more correct term is door fan.
digital gauge	For the purpose of this Protocol, it is a gauge with an electronic pressure sensor and digital display that is capable of reading in tenths of a Pascal.
Effective Leakage Area	EfLA at 4 Pa using 1.0 discharge coefficient which is not to be confused with EqLA which is normally 50% larger

Term	Definition
enclosure	The surface bounding a volume, which is connected to outdoors directly. For example an apartment whose only access to outdoors was through a doorway that leads directly outdoors. Or, a building with a series of apartments or offices whose only access to the outdoors is through a common hallway then the enclosure would be the volume that bounds all of the apartments or offices.
Equivalent Leakage Area	EqLA, usually taken at 10 Pa using 0.61 discharge coefficient, but for the purposes of this document, it is taken at 75 Pa.
envelope	See enclosure.
exterior enclosure	See enclosure. The addition of the word exterior emphasizes the fact that we are primarily dealing with enclosures that face the outdoors. The boundary or air barrier separating the interior conditioned volume of a building from the outside environment. This represents the enclosure that faces the “exterior,” but is actually measured from inside the building.
fan-pressurization method	Term is used in the ASTM standard and does a decent job of describing what a door fan test is except that it may delude us into thinking that depressurization is not an option.
sq ft	This refers to “square feet.” In this document it usually refers to the surface area of the envelope, which is also called “the enclosure.”
micromanometer	A digital gauge that is capable of reading in tenths of a Pascal.
outdoors	Outside the building in the area around the building.
readings	Discrete pressure or flow values read from the gauge(s). Typically five or six readings or samples are taken every second when using a digital micromanometer, which may not be apparent since the display is updated every second.
test points	Consists of a group of readings taken over a 10–30 second time period, which are typically averaged to produce one test point that could be used as one of the multiple points in a curve fit or overall average.
time averaging	Refers to the digital gauge display that must have an adjustable averaging from 1 second to 1 minute for the purpose of averaging fluctuating pressure signals. Averaging can be block averages that will update for the length of the average or rolling (moving) averages that will update continuously by displaying the average over the past time period.
single zone	A space in which the pressure difference between any two places, differ by no more than 5% of the inside to outside pressure difference.
static pressure	See bias pressure.
zero flow pressure	ASTM terminology for bias pressures.

8.2 Acronyms and Abbreviations

Term	Spellout
ACH	air changes per hour
AOR	Architect of Record
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
ATTMA	Air Tightness Testing and Measurement Association
CD	Compact Disk
CE	

Term	Spellout
CERL	Construction Engineering Research Laboratory
CFM	cubic feet per minute
CGSB	Canadian General Standards Board
CI	Confidence Interval
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
EfLA	Effective Leakage Area
EqLA	Equivalent Leakage Area
ERDC	Engineer Research and Development Center
ERDC-CERL	Engineer Research and Development Center, Construction Engineering Research Laboratory
HVAC	heating, ventilating, and air-conditioning
IR	infrared
ISO	International Organization for Standardization
ITC	Infrared Training Center
NIST	National Institute of Standards and Technology
STP	standard temperature and pressure conditions of 14.696 psi (101.325 KPa) and 68F (20°C).
UEPH	Unaccompanied Enlisted Personnel Housing
UK	United Kingdom
U.S.	United States
USACE	U.S. Army Corps of Engineers



REQUEST FOR PROPOSAL



APPENDIX-HH

COMMISSIONING

SECTION 01 91 00

COMMISSIONING

01/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED (2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

ASSOCIATED AIR BALANCE COUNCIL (AABC)

ACG Commissioning Guideline (2005) Commissioning Guideline

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB Commissioning Standard (1999) Procedural Standards for Building Systems Commissioning

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Commissioning Manual (1994, 1st Ed) HVAC Systems Commissioning Manual

1.2 DEFINITIONS and Abbreviation's

1.2.1 Abbreviation's

The following are common abbreviations used in the Specifications and in the Commissioning Plan. Definitions are found in Section 1.6.

A/E Architect/Design Engineer(Gov't)	FIO For Information Only
CA Commissioning Authority/Specialist	FT Functional Performance Test
CC Controls Contractor	CG General Contractor (prime)
Cx Commissioning	MC Mechanical Contractor
Cx Plan Commissioning Plan document	PC Prefunctional checklist
EC Electrical Contractor	PM Project Manager(Gov't)
TAB Test and Balance Contractor	Subs Subcontractors to General

1.2.2 Definitions

- 'a. "Basis of design" is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the design intent. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. Some reiterating of

the design intent may be included.

- b. "Commissioning (Cx)" is a comprehensive and systematic process to verify that the building systems perform as designed to meet Government requirements and the design intent.
- c. "Commissioning Plan" (Cx Plan) is an overall plan that provides the structure, schedule and coordination planning for the Cx process.
- d. "Data logging" records data such as flows, currents, status, and pressures over time using stand-alone data loggers separate from the control system.
- e. "Deferred functional tests" are performed after substantial completion, due to partial occupancy, equipment, seasonal requirements, design, or other site conditions that disallow the test from being performed before substantial completion.
- f. A "deficiency" is a condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the Contract documents.
- g. The "design intent" represents the ideas, concepts, and criteria that are conveyed through the Contract documents.
- h. "Factory testing" tests equipment on-site or at the factory by factory personnel.
- i. A "functional performance test" (FT) tests the dynamic function and operation of equipment and systems under full operation using manual (direct observation) or monitoring methods. For example, the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint.
- j. "Indirect indicators" indicate a response or condition, such as a reading from a control system screen reporting a damper to be 100 percent closed.
- k. A "manual test" uses hand-held direct reading instruments, immediate control system readouts, or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the observation).
- l. "Nonconformance" means a piece of equipment or a system does not perform properly or comply with the design intent.
- m. An "overwritten value" is a sensor value in the building control system that is overridden to see the response of a system. For example, changing the outside air temperature value from 50 degrees F to 75 degrees F to verify economizer operation. See also "simulated signal."
- n. "Phased commissioning" is completed in phases (by floors or buildings, for example) due to the size of the structures or other scheduling issues, in order to minimize the total construction time.
- o. A "prefunctional checklist" (PC) is a list of items to inspect and elementary component tests to conduct to verify proper installation of

equipment, provided by the Contractor with the assistance of the Commissioning Agent. PCs are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated). However, some PC items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). PCs augment and are combined with the manufacturer's startup checklist.

- p. "Sampling" functionally tests only a fraction of the total number of identical or near identical pieces of equipment.
- q. "Seasonal performance tests" are FTs that are deferred until the system(s) will experience conditions closer to their design conditions.
- r. "Simulated conditions" are created conditions for the purpose of testing the response of a system (e.g., applying a hair blower to a space sensor to see the response in a VAV box).
- s. A "simulated signal" uses a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.
- t. "Startup" includes the initial starting or activating of dynamic equipment and executing PCs.
- u. "Test requirements" specify what modes, functions, and conditions shall be tested. The test requirements are not the detailed test procedures. The test requirements are specified in the individual sections of the Contract documents.
- v. "Trending" uses the building control system for monitoring.
- w. The "warranty period" involves the entire project, including equipment components. Warranty begins at substantial completion and extends for at least one year, unless specifically noted otherwise in the Contract documents and accepted submittals.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; The following shall be submitted:

SD-02 Shop Drawings

Commissioning Plan; G

Commissioning Plan prepared in accordance with Commissioning Standard, no later than 28 days after the approval of the Commissioning Specialist.

SD-03 Product Data

Pre-Functional Performance Test Checklists; G

At least 28 days prior to the start of Pre-Functional

Performance Test Checks. Submit the schedule for the test checks at least 14 days prior to the start of Pre-Functional Performance Test Checks.

Functional Performance Tests; G

Test procedures at least 28 days prior to the start of Functional Performance Tests. The schedule for the tests at least 14 days prior to the start of Functional Performance Tests.

SD-07 Certificates

Commissioning Firm; G

Certification of the proposed Commissioning Firm's qualifications by one of the following ACG, NEBB, or TABB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. Include in the documentation the date that the Certification was initially granted and the date when the current Certification expires. Any lapses in Certification of the proposed Commissioning Firm or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Firm shall be described in detail.

Commissioning Authority; G

Certification of the proposed Commissioning Authority's qualifications by one of the following ACG, NEBB, or TABB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. The documentation shall include the date that the Certification was initially granted and the date when the current Certification expires. Any lapses in Certification of the proposed Commissioning Specialist or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Authority shall be described in detail.

SD-11 Closeout Submittals

Commissioning Report; G

No later than 14 days after completion of Functional Performance Tests.

1.4 QUALITY ASSURANCE

1.4.1 Commissioning Firm

Provide a Commissioning Firm that is either a member of ACG or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, immediately notify the Contracting Officer and submit another Commissioning Firm for approval. Any firm that has been the subject of disciplinary action by the ACG, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties

related to the HVAC systems, including Commissioning. All work specified in this Section and in other related Sections to be performed by the Commissioning Firm shall be considered invalid if the Commissioning Firm loses its certification prior to Contract completion and must be performed by an approved successor. These Commissioning services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The Commissioning Firm shall be a subcontractor of the prime Contractor and shall be financially and corporately independent of all other subcontractors. The Commissioning Firm shall report to and be paid by the prime Contractor.

1.4.2 Commissioning Authority

1.4.2.1 General

The Commissioning Authority shall be an ACG Certified Commissioning Agent, a NEBB Qualified Commissioning Administrator, or a TABB Certified Commissioning Supervisor and shall be an employee of the approved Commissioning Firm. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Commissioning Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another Commissioning Specialist for approval. Any individual that has been the subject of disciplinary action by the ACG, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including Commissioning. All work specified in this Section and in other related Sections performed by the Commissioning Specialist shall be considered invalid if the Commissioning Specialist loses his certification prior to Contract completion and must be performed by the approved successor.

1.4.2.2 Responsibilities

Perform all Commissioning work specified herein and in related sections under the direct guidance of the Commissioning Specialist. The Commissioning Specialist shall prepare the Commissioning Plan, which will be a comprehensive schedule and will include all submittal requirements for procedures, notifications, reports and the Commissioning Report. After approval of the Commissioning Plan, revise the schedule to reflect the schedule requirements in the Commissioning Plan.

1.5 DESCRIPTION

The Cx process shall encompass and coordinate system documentation, equipment startup, control system calibration, testing and balancing, performance testing, and training. Cx shall begin in the design phase by documenting the design intent and continue through the construction phase and warranty period with actual verification of performance. Cx shall be completed before substantial completion. Cx does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

1.5.1 Process

The following activities outline the Cx tasks specified in this section and the general order in which they occur. The Commissioning Agent (CA) shall coordinate all activities. The Quality Control System established under Section 01 45 01 USACE Quality Control Shall be maintained.

- a. Review design development and construction documents and document the basis of design and design intent.
- b. Conduct a scoping meeting to review the Cx process with the Cx team members.
- c. Develop a Cx Plan.
- d. Schedule additional meetings throughout construction with necessary parties attending, to plan, scope, coordinate, schedule future activities, and resolve problems.
- e. Collect equipment documentation during normal submittals, including detailed startup procedures.
- f. Review submittals.
- g. Develop startup plans, startup documentation formats, and PCs to be completed during the startup process.
- h. Perform startup and initial checkout.
- i. Develop and execute FT procedures.
- j. Correct items of nonconformance in materials, installation, or setup and retest the system.
- k. Submit a Deficiency Report and Resolution Record.
- l. Review documentation for completeness.
- m. Complete and submit the Final Cx Report.
- n. Review, pre-approve and coordinate Government personnel training and verify completion.
- o. Perform deferred testing as specified and required, including unforeseen deferred tests, seasonal testing, short-term diagnostic testing, and end-of-warranty review.

1.5.2 Written Work Products

The Cx process generates a number of written work products. The Cx Plan shall list all the formal written work products, describe briefly their contents, who is responsible to create them, their due dates, who receives and approves them and the location in the specification to create them. In summary, the written products are:

Product	Developed By	Approved by
Design and document review	CA	PM, A/E
Draft and Final Cx Plan	CA	PM, A/E
Meeting minutes	Contractor	
Cx schedules	Contractor, CA,	
Equipment documentation submittals	Contractor	CA
Sequence clarifications	Contractor	CA
PCs	Contractor with CA assistance	CA, A/E

Product	Developed By	Approved by
Startup and initial checkout plan	Contractor, CA compiles existing documents	CA
Completed startup, initial checkout, and PC forms	Contractor	CA, A/E
TAB Plan	Contractor	CA
Final TAB report	Contractor	CA
Issues log (deficiencies)	CA	PM, A/E
Cx Progress Record	CA	PM, A/E
Deficiency reports	CA	PM, A/E
FT forms	Contractor	CA, PM
Completed FT forms	Contractor	
O&M manual data	Contractor	
Cx record book	CA	
Training Plan	Contractor, CA	
Specific training agendas	Contractor	
Final Cx Report	CA	
Miscellaneous approvals	PM	

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

SD-02 Shop Drawings

SD-11 Closeout Submittals G

Final Cx Report

1.7 SYSTEMS TO BE COMMISSIONED

The following equipment and systems shall be commissioned in accordance with the procedures described in this section.

- a. Division 23 systems (all mechanical HVAC Equipment including ductwork and piping, on passive and mechanical systems, and DDC Control)
- b. Division 7 Building Air Barrier
- c. Division 22 Plumbing systems and technologies (including water collection, treatment, and heating)
- d. Division 26 Daylighting systems (including lighting controls)

1.8 COORDINATION

1.8.1 Commissioning Team

The members of the Cx team shall consist of the CA, the CG, the PM, A/E, subcontractors, QC Specialists, Government representative(s) including operation and maintenance (O&M) staff. All members shall work together and with vendors to fulfill their contracted responsibilities and meet the

objectives of the Contract documents and Cx process. The CA shall regularly communicate with all members of the Cx team, keeping them apprised of Cx progress and scheduling changes through memos, progress reports, or other methods of communication.

1.8.2 Cx Schedule

The CA shall work with the CG and the PM to schedule the Cx activities. The CA shall provide the initial schedule of primary events at the Cx scoping meeting. The Draft Cx Plan shall provide a format for this schedule, and both shall be submitted together. The CA shall provide sufficient notice to the CG and the PM for scheduling Cx activities. The Contractor shall integrate all Cx activities into the master schedule. As the construction progresses the CA shall update the Cx schedule with more details. Notify the PM and CA ahead of time when Cx activities not yet performed or not yet scheduled will impact the construction schedule.

1.8.3 Meetings

1.8.3.1 Scoping Meeting

The Cx scoping meeting shall be scheduled by the CA within 90 days of award of the construction Contract. The CA shall plan and conduct the Cx scoping meeting with the entire Cx team in attendance. Meeting minutes shall be distributed to all parties within one week. The agenda shall include a review of each building system to be commissioned, including its intended operation, Cx requirements, and completion and startup schedules. The scope of work, tasks, schedules, deliverables, and responsibilities for implementation of the Cx Plan shall be established. Information gathered from this meeting will allow the CA to update the Cx Plan, which shall also be distributed to all parties.

1.8.3.2 Miscellaneous Meetings

Other meetings will be planned and conducted by the CA as construction progresses. These meetings will cover coordination, deficiency resolution, and planning issues. These meetings shall be held monthly, until the final three months of construction when they shall be held weekly. Cx shall also be discussed in all weekly progress meetings.

1.9 RESPONSIBILITIES

The responsibilities of various parties in the Cx process are as specified. The PM, A/E and CA are not responsible for construction means, methods, job safety, or management function related to Cx on the job site.

1.9.1 CA Responsibilities

The CA is responsible for writing and verification of compliance with the Cx Plan and the preparation of Cx checklists and reports. This shall involve coordinating and directing the Cx activities in a logical, sequential, and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules, and technical expertise. All submittals applicable to systems being commissioned shall be reviewed and evaluated by the CA for compliance with Cx needs and the Contract documents. The CA shall ensure proper

coordination and submission of all documents. During construction, the CA shall perform site visits as necessary to observe component and system installations; attend selected planning and job-site meetings to obtain information on construction progress; review construction meeting minutes for potential revisions or substitutions related to the Cx process; and assist in resolving any discrepancies.

1.9.2 Contractor Responsibilities

During construction, the CG shall maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. These drawings shall be updated after completion of Cx (excluding deferred testing).

1.10 COMMISSIONING PLAN

The CA shall develop a Draft Cx Plan to identify how Cx activities will be integrated into general construction and trade activities. Various templates are available on the [PECI website](#). The Plan shall identify how Cx responsibilities are distributed. The Specifications will take precedence over the Cx Plan in the event of conflicting requirements between the two. The Cx Plan shall include the following components:

- a. A brief overview of the Cx process, including goals, objectives, and general project information.
- b. A list of systems to be commissioned.
- c. Identification of Cx participants and responsibilities.
- d. A description of the management, communication, and reporting of the Cx Plan.
- e. An outline of the Cx process scope including:
 1. Documentation of basis of design and design intent.
 2. Startup and testing procedures, including sampling procedures.
 3. Observation procedures. Provide copy of applicable section of QC Plan. Highlight the requirements for verification of the correct installation of all systems.
 4. System performance verification.
 5. Submittal review procedures. Provide a copy of Section VI of the QC Plan.
 6. O&M documentation. Describe the information to be provided to the client as required by Contract under operation and maintenance data.
 7. Training activities. Provide a copy of Section within the QC Plan.
 8. Warranty period activities.

- f. A list and description of the written work products, as specified in the paragraph Written Work Products.
- g. An activity schedule.
- h. A description of the rigor, scope, and procedures of testing and acceptance. Provide a copy of **applicable section** of the QC Plan.

The Draft Cx Plan shall be submitted to the **PM** before the scoping meeting. Within 30 days after the initial Cx scoping meeting the CA shall update and submit the Draft Cx Plan for **PM and A/E** final review and approval. The CA shall adjust the Draft Cx Plan as required and submit as the **Final Cx Plan** prior to commencement of work. The Final Cx Plan shall include specific scheduling of required testing procedures for commissioned equipment and systems. A **Commissioning Agent Certification Letter** signed by the CA shall be submitted, certifying the Cx Plan has been successfully executed and the design intent of the facility has been achieved.

1.11 CX TEAM TRAINING

The **CG** shall provide training according to a written **training plan** to Cx team members as determined by the CA prior to commencement of construction. The first training session shall describe the overall system design concept and the design concept of each equipment section. This presentation shall include a review of systems using the simplified system schematics (one-line drawings) including chilled water systems, condenser water or heat rejection systems, heating systems, fuel oil and gas supply systems, supply air systems, exhaust systems, and/or outside air strategies, as determined by the CA. For the primary HVAC equipment, the **CG** shall provide a short discussion of the control of the equipment during the mechanical or electrical training. One training session shall include a presentation discussing the use of the blank FT forms for recommissioning equipment.

1.12 COMMISSIONED EQUIPMENT DATA

The CA shall request in writing from the **CG** specific information needed about each piece of commissioned equipment or system to fulfill requirements of the Cx Plan, and shall review and evaluate this information for compliance with Cx needs, in accordance with this section and **specification** Section **addressing** SUBMITTAL PROCEDURES. This information shall include normal cut sheets; addenda; change orders; full details of any required testing; full factory testing reports, if any. In addition, the installation, startup, and checkout materials that are shipped inside the equipment and the actual field checkout forms to be used by the factory or field technicians shall be submitted to the CA. The CA may request further documentation as necessary for the Cx process. Any request for additional data shall be made prior to receipt of normal submittal data from equipment manufacturers. This information is to be used in the Cx process prior to the regular formal O&M manual submittals, and shall be compiled and maintained in a building systems book to be included in the O&M manuals.

1.13 REPORTING

The CA shall provide Cx progress reports monthly to the **PM** and Cx team, with increasing frequency as construction and Cx progress. Sample standard forms shall be provided and referenced in the Cx Plan. Example standard

forms are available for reference in Appendix B and on the [PECI website](#). Testing or review approvals and nonconformance and deficiency reports shall be made regularly.

1.13.1 Cx Report

The CA shall compile a Cx Report focusing on evaluating Cx process issues, and provide four copies to the PM within 30 days after occupancy. The report shall summarize all of the tasks, findings, conclusions, and recommendations of the Cx process. A list of participants and roles, brief building description, overview of Cx and testing scope, and general description of testing and verification methods shall be included. The CA shall provide the following for each piece of equipment:

- a. Assessment of how the equipment meets the specifications and design intent.
- b. Equipment installation verification.
- c. O&M documentation evaluation.
- d. Operator training evaluation.
- e. Assessment of the value of the Cx process.

Specifically list all outstanding nonconformance items. Each nonconformance issue shall be referenced to the specific item where the deficiency is documented. List any uncorrected compromises in the environmentally responsive features. List recommendations such as improvements to equipment or operations, future actions including testing justified by seasonal conditions, or Cx process changes. Include a brief description of the verification method used and observations and conclusions from the testing of each piece of equipment. All acquired Cx documentation, including completed FTs, logs, minutes, reports, deficiency lists, communications, findings, and unresolved issues, shall be compiled in appendices and provided with the Cx Report.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

Equipment shall be maintained in good repair and operational condition throughout the duration of use on this project.

2.1.1 Equipment Provisions

The CG shall provide all test equipment necessary to perform startup and initial checkout and required FT. Special equipment, tools and instruments available only from the vendor, specific to a piece of equipment, and required for testing equipment shall be turned over to the PM after testing has been completed.

2.1.2 Equipment Calibration

All testing equipment shall be of sufficient quality and accuracy to test and measure system performance within the tolerances specified. Unless otherwise noted, the following minimum requirements apply. Temperature

sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.9 degrees F and a resolution of plus or minus 0.2 degrees F. Pressure sensors shall have an accuracy of plus or minus 2.0 percent of the value range being measured (not the full range of the meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available. Calibration documentation of all testing equipment shall be turned in with each testing episode. Serial numbers of equipment and standards used for QC, zeroing, and calibration shall be included.

PART 3 EXECUTION

3.1 STARTUP AND PREFUNCTIONAL CHECKOUT

Each piece of equipment or system to be commissioned shall receive a full prefunctional checkout. No sampling strategies shall be used. Equipment shall not be temporarily started for Cx.

3.1.1 Responsibilities

The CG has startup responsibility and shall complete systems and subsystems so they are fully functional and meeting the design objectives of the Contract documents. The Cx procedures and FT do not relieve or lessen this responsibility or shift that responsibility partially to the CA or the Government. Parties responsible for PC execution and startup shall be identified in the Cx scoping meeting and in the PCs.

3.1.2 Startup and Checkout Plan

The CA shall assist the CG in developing PCs and detailed startup plans for all equipment. The primary role of the CA in this process is to witness and ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.

3.1.2.1 PCs

The PCs shall indicate required procedures to be executed as part of startup and prefunctional checkout of the systems. The CG shall determine which trade is responsible for executing and documenting each of the line item tasks and note that trade on the PC. Each task may have more than one trade responsible for its execution.

3.1.2.2 Startup

The CG shall develop the full startup plan and submit the plan to the CA PM and A/E for review and approval. The CA PM and A/E shall review and evaluate the procedures and the procedure documentation format, noting any procedures that need to be revised or added. The plan shall contain a minimum of the following:

- a. PCs.
- b. The manufacturer's standard written startup procedures copied from the installation manuals with check boxes by each procedure and a summary statement with a signature block added at the end.

c. The manufacturer's field checkout sheets.

3.1.3 Execution of PCs and Startup

Four weeks prior to startup, the CG shall schedule startup and checkout activities with the Contracting Officer and CA. The performance of the PCs, startup, and checkout shall be directed and executed by the CG and witnessed by the CA. The CG shall provide skilled technicians to execute starting of equipment and shall ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments, and problem-solving. The CA and PM representative shall observe the procedures for each piece of equipment.

3.1.4 Documentation

After startup completion, the CG shall provide the CA with a signed and dated copy of the completed startup and prefunctional tests and checklists. Only individuals that have direct knowledge and witnessed that a line item task on the PC was actually performed shall initial or check that item off. Witnessing supervisors shall not fill out these forms.

3.1.5 Nonconformance and Approval in PCs and Startup

The CG shall clearly list any outstanding items of the startup and prefunctional procedures that were not completed successfully at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the PM and the CA within two days of test completion. The CA shall review the report and submit either a nonconformance report or an approval form to the PM. The CA shall work with the CG to correct and retest deficiencies or uncompleted items. The CA will involve the PM and others as necessary. The CG shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated startup report and a Statement of Correction on the original nonconformance report. When satisfactorily completed, the CA shall recommend approval of the execution of the PCs and startup of each system to the PM using a standard form.

3.1.6 Phased Commissioning

The project may require startup and initial checkout to be executed in phases. This phasing shall be planned and scheduled in a coordination meeting of the CA, PM, and the CG. Results will be added to the master and Cx schedule.

3.2 SENSOR AND ACTUATOR CALIBRATION

All field-installed temperature, relative humidity, CO2 and pressure sensors and gages, and actuators (dampers and valves) on all equipment shall be calibrated. Test instruments shall have had a certified calibration within the last 12 months. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated. Procedures used shall be fully documented on the PCs or other suitable forms, along with written documentation of initial, intermediate and final results.

3.2.1 Calibration Methods

Alternate methods may be used, if approved by the Government beforehand.

3.2.1.1 All Sensors

The CG shall verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cables are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, verify they are reading within 0.4 degrees F of each other for temperature and within a tolerance of each other equal to two percent of the reading for pressure. Tolerances for critical applications may be tighter.

3.2.1.2 Sensors Without Transmitters

Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage, or building automation system (BAS)) is within the tolerances listed in the table below in paragraph Tolerances, Standard Applications of the instrument-measured value. If not, install offset in BAS, calibrate, or replace sensor.

3.2.1.3 Sensors With Transmitters

Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the BAS. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship, and P/I reaction. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage, or BAS) is within the tolerances listed in the table below in paragraph Tolerances, Standard Applications of the instrument-measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

3.2.2 Tolerances, Standard Applications

Sensor	Required Tolerance (+/-)
Cooling coil, chilled and condenser water temps	0.7 F
Flow rates, water	4% of design
Relative humidity	4% of design
AHU wet bulb or dew point	3.6 F
Combustion flue temps	9.0 F
Hot water coil and boiler water temp	2.7 F
Oxygen or CO2 monitor	0.1% pts
Outside air, space air, duct air temps	0.7 F
CO monitor	0.01% pts
Watt-hour, voltage & amperage	1% of design
Natural gas and oil flow rate	1% of design
Pressures, air, water and gas	3% of design
Steam flow rate	3% of design
Flow rates, air	10% of design

Sensor	Required Tolerance
Barometric pressure	1.0 inch of Hg

3.2.3 Valve and Damper Stroke Setup and Check

3.2.3.1 EMS Readout

For all damper actuator positions checked, verify the actual position against the BAS readout. Set pumps or fans to normal operating mode. Command damper closed, visually verify that damper is closed and adjust output zero signal as required. Command damper open, verify position is full open and adjust output signal as required. Command damper to three intermediate positions. If actual damper position doesn't reasonably correspond, replace actuator.

3.3 CONTROLS

Controls shall be tested and verified after startup and prefunctional checkout and after sensor and actuator calibration, as specified here and in Section [Specification Section 23](#). The CG shall be responsible for Cx activities related to controls. Before initial startup, the CG shall gather and review the current control sequences and interlocks and with the CA write detailed testing procedures.

3.3.1 Control Drawings

Submit control drawings that include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications.

3.3.1.1 Content

Drawings shall include:

- a. An overview narrative of the system (one or two paragraphs) generally describing system purpose, components, and function.
- b. All interactions and interlocks with other systems.
- c. Detailed delineation of control between any packaged controls and the BAS, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
- d. Written sequences of control for packaged controlled equipment.
- e. Startup sequences.
- f. Warm-up mode sequences.
- g. Normal operating mode sequences.
- h. Unoccupied mode sequences.
- i. Shutdown sequences.
- j. Capacity control sequences and equipment staging.

- k. Temperature and pressure control (e.g., setbacks, setups, resets).
- l. Detailed sequences for all control strategies (e.g., economizer control, optimum start/stop, staging, optimization, demand limiting).
- m. Effects of power or equipment failure with all standby component functions.
- n. Sequences for all alarms and emergency shut downs.
- o. Seasonal operational differences and recommendations.
- p. Initial and recommended values for all adjustable settings, setpoints, and parameters that are typically set or adjusted by operating staff. Include any other control settings, fixed values, or delays that will be useful during testing and operating the equipment.
- q. Schedules, if known.

3.3.1.2 Format

To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered. The control drawings shall have a key to all abbreviations, and shall contain graphic schematic depictions of the systems and each component. The schematics shall include the system and component layout of any equipment that the building control system monitors, enables, or controls, including equipment primarily controlled by packaged or integral controls. Provide a full points list with the following included as a minimum for each point:

- a. Controlled system
- b. Point abbreviation
- c. Point description (e.g., DB temp, airflow)
- d. Display unit
- e. Control point or setpoint (Yes / No) (Point that controls equipment and can have its setpoint changed)
- f. Monitoring point (Yes / No) (Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification)
- g. Intermediate point (Yes / No) (Point whose value is used to make a calculation which then controls equipment; e.g., space temperatures that are averaged to a virtual point to control reset)
- h. Calculated point (Yes / No) ("Virtual" point generated from calculations of other point values)

The CG keep the PM, A/E and the CA informed of all changes to this list during programming and setup. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls

O&M manual submittal, as specified in Division 01 of Specifications.

3.3.2 Controls Initial Checkout

Indicate what tests on what systems should be completed prior to TAB using the building control system for TAB work. Coordinate with the CA, PM and TAB contractor for this determination. Provide a signed and dated certification to the CA and PM upon completion of the checkout of each controlled device, equipment, and system prior to FT for each piece of equipment or system, that all system programming is complete with reference to all aspects of the Contract documents, except FT requirements. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control, and virtual points as specified. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air, water, and building pressure). The CG shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout, and adjust the building control system prior to FT. At a minimum, the plan shall include for each type of equipment controlled by automatic controls:

- a. System name.
- b. List of devices.
- c. Step-by-step procedures for testing each controller after installation, including:
 1. Process of verifying proper hardware and wiring installation.
 2. Process of downloading programs to local controllers and verifying that they are addressed correctly.
 3. Process of performing operational checks of each controlled component.
 4. Plan and process for calibrating valve and damper actuators and all sensors.
 5. A description of the expected field adjustments for transmitters, controllers, and control actuators should control responses fall outside of expected values.
- d. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.
- e. A description of the instrumentation required for testing.

3.3.3 Controls FT

The CA shall assist the CG in executing controls testing. Using a skilled technician who is familiar with this building, execute the FT of the controls system as specified for the controls contractor in Section Section 23 09 23 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS.

Execute all control system trend logs specified in Section 23 09 23 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS Section 23 09 23 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS. The building control system shall be sufficiently tested and approved by the CA and the PM before it is used for TAB or to verify performance of other components or systems.

3.4 TAB

TAB shall be completed after controls are tested, checked out, and adjusted. The CG shall be responsible for TAB preparation and activities, as specified here and in Section 23 05 93.00 10 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.4.1 TAB Plan

Six weeks prior to starting TAB, submit an outline of the TAB plan and approach for each system and component to the CA, PM, and the controls contractor. This plan shall be developed after the TAB contractor has some familiarity with the building control system, and shall be reviewed by the CA. The TAB contractor shall review the TAB plan to determine the capabilities of the building control system toward completing TAB. The submitted plan shall include:

- a. Certification that the TAB contractor has reviewed the construction documents and the systems with the CG to sufficiently understand the design intent for each system.
- b. An explanation of the intended use of the building control system. The controls contractor will comment on feasibility of the plan.
- c. Field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted, and balanced with the data cells to be gathered for each.
- d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
- e. Final test report forms to be used.
- f. Detailed step-by-step procedures for TAB work for each system and issue (e.g., terminal flow calibration for each terminal type, diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions). Criteria for using air flow straighteners or relocating flow stations and sensors shall be discussed. Provide the analogous explanations for the water side.
- g. List of all air flow, water flow, sound level, system capacity, and efficiency measurements to be performed and a description of specific test procedures, parameters, and formulas to be used.
- h. Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pilot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic.).

- i. Identification and types of measurement instruments to be used and their most recent calibration date.
- j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.
- k. Confirmation that the TAB contractor understands the outside air ventilation criteria under all conditions.
- l. Details of whether and how minimum outside air infiltration will be verified and set, and for what level (e.g., total building, zone).
- m. Details of how building static and exhaust fan/relief damper capacity will be checked.
- n. Proposed selection points for sound measurements and sound measurement methods.
- o. Details of methods for making any specified coil or other system plant capacity measurements.
- p. Details of any TAB work to be done in phases (e.g., by floor, by building).
- q. Details regarding specified deferred or seasonal TAB work.
- r. Details of any specified false loading of systems to complete TAB work.
- s. Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.
- t. Details of any required interstitial cavity differential pressure measurements and calculations.
- u. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests, and lists of completed tests (scope and frequency).
- v. Plan for formal progress reports (scope and frequency).
- w. Plan for formal deficiency reports (scope, frequency, and distribution).

3.4.2 Scheduling

Prepare a preliminary schedule for Division 23 pipe and duct system testing, flushing, cleaning, equipment startup, and TAB start and completion for use by the CA. Update the schedule as appropriate, and notify the PM and CA prior to the start of each activity.

3.4.3 Preparation

Meet with the TAB contractor prior to beginning TAB. Provide the TAB contractor any needed unique instruments for setting terminal unit boxes and instructions for their use; for instance, handheld control system

interface for use around the building during TAB. For a given system, have required PCs, calibrations, startup, and selected FTs completed and approved by the CA prior to TAB. Install a P/T plug at each water sensor that is an input point to the control system. List and clearly identify on the as-built drawings the locations of all air-flow stations. Provide test holes in ducts and plenums where directed by the TAB contractor to allow air measurements and air balancing, providing an approved plug. Provide temperature and pressure taps according to the Contract documents for TAB and Cx testing. Provide sufficient FT of the HVAC control system and evaluate its use for TAB before TAB is executed. Put all HVAC equipment and systems into operation and continue the operation during each working day of TAB and Cx, as required.

3.4.4 TAB Execution

Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for the TAB contractor to operate the system without assistance. The CA shall witness the HVAC piping test and flushing procedures and the ductwork testing and cleaning procedures, sufficiently to be confident that proper procedures are followed. Testing results shall be documented and copies provided to include in the O&M manuals. Notify the PM of any deficiencies in results or procedures. The CA shall evaluate air and water systems balancing by initiating spot testing, by reviewing completed reports, and by selected site observation. Air and water TAB shall be completed with discrepancies and problems remedied before FT of the respective air- or water-related systems.

3.4.5 TAB Reports

A running log of events and issues shall be kept by the TAB contractor. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests, and lists of completed tests to the CA and PM a minimum of twice a week. Communicate in writing to the controls contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the building control system setup and operation. Provide a draft TAB report to the CA within two weeks of TAB completion. The report shall contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. Provide the CA and PM with any requested data gathered but not shown on the draft reports. Provide a final TAB report with details for CA review and PM and A/E approval.

3.5 FUNCTIONAL PERFORMANCE TESTING

The CA shall direct, witness, and document the FT of all equipment and systems. The CG shall execute the tests with skilled technicians provided under the direction of the CA. Systems shall be tested under all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, full range of part- and full-load) and under abnormal modes and conditions (power failure, interlocks with other equipment, alarms, no flow, equipment failure). The CG shall verify that systems are run through all the building control system's sequences of operation, and components shall be verified to be responding as the sequences state. The CA shall assist the CG to develop the FT procedures in a sequential written form, and coordinate, oversee, and document the actual testing.

3.5.1 Development of Test Procedures

Before test procedures are written, the CG shall obtain all requested documentation regarding equipment sequence of operation and testing procedures, including procedures for equipment installed by factory representatives and a current list of change orders affecting equipment or systems. The change orders shall include an updated points list, program code, control sequences, and parameters. Using the testing parameters and requirements found in the technical sections **manufacturer's recommendations** of commissioned equipment and systems the CG shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. The CG shall assist the CA in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings, or equipment documentation is not sufficient for writing detailed testing procedures. Prior to execution, the CG shall provide a copy of the test procedures to the CA who shall review the tests for feasibility, safety, equipment operation, sequences, and warranty protection. The test procedure forms shall include the following, at a minimum:

- a. System and equipment or component name(s) and configuration(s).
- b. Equipment location and ID number.
- c. Unique test ID number, and reference to unique PC and startup documentation ID numbers.
- d. Date.
- e. Project name.
- f. Participating parties.
- g. A copy of the section describing the test requirements.
- h. A copy of the specific sequence of operations or other specified parameters being verified.
- i. Formulas used in any calculations.
- j. Required pre-test field measurements.
- k. Instructions for setting up the test, including special cautions, alarm limits, or other equipment-specific information.
- l. Specific step-by-step procedures to execute the test in a clear, sequential, and repeatable format.
- m. Acceptance criteria of proper performance with a Yes / No check box to allow for clear marking of whether or not proper performance of each part of the test was achieved.
- n. A section for comments.
- o. Signature and date blocks for the CA, Contractor, PM and A/E.

3.5.2 Test Methods

3.5.2.1 Functional Performance

FT and verification shall be achieved by manual testing or by monitoring the performance and analyzing the results using the energy management control system's trend log capabilities or by stand-alone data loggers. A combination of methods may be required to test the complete sequence of operations. The A/E and CA shall determine which method, or combination of methods, is most appropriate for tests that do not have a method specified. The CG shall provide FT of commissioned equipment and systems. CA and A/E shall analyze any functional performance trend logs and monitoring data to verify performance, and witness and evaluate manual FTs performed by the CG. The CG shall assist the CA in interpreting the monitoring data, as necessary.

3.5.2.2 Simulated Conditions

Simulating conditions (not by an overwritten value) shall be allowed only when timing the testing to experience actual conditions is not practical. Sensors, transducers, and devices shall have been calibrated before simulating conditions.

3.5.2.3 Overwritten Values

Overwriting sensor values to simulate a condition shall be allowed only when simulating conditions in other ways is not practical, and shall be used with caution. Sensors, transducers and devices shall have been calibrated before overwriting values.

3.5.2.4 Altering Setpoints

Altering setpoints to test a sequence is an acceptable alternative to overwriting sensor values when simulating conditions in other ways is not practical.

3.5.2.5 Indirect Indicators

Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the building control system represent actual conditions and responses. Much of this verification shall be completed during prefunctional testing.

3.5.2.6 Setup

Each function and test shall be performed under conditions that simulate actual conditions as close as possible. The CG shall provide materials, system modifications, and other necessities to produce the flows, pressures, temperatures, or other values necessary to execute the test according to the specified conditions. Where equipment requires integral safety devices to stop or prevent equipment operation unless minimum safety standards or conditions are met, FT procedures shall demonstrate the actual performance of safety shutoffs in real or closely-simulated conditions of failure. At completion of the test, the CG shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test conditions.

3.5.3 Coordination and Scheduling

FT shall be performed after PCs, startup, calibration, and TAB are complete for a given system. The CA shall schedule FTs through the CG and PM. Testing shall proceed from components to subsystems to systems; when the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems shall be checked.

3.5.4 Documentation

The CA shall document the results of all FTs using the specific test procedure forms developed by the CA for that purpose. The CG shall submit copies of the completed forms with the O&M manual data and as part of the Cx Report.

3.6 NONCONFORMANCE

Every effort shall be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. Nonconformance and deficiencies observed in materials, installation, or operation shall be addressed immediately, in terms of notification to responsible parties, and providing recommended actions to correct deficiencies. The CG shall have responsibility for resolving construction deficiencies, and the CA shall assist with problem solving as necessary. If a design revision is deemed necessary and approved by the PM, the designer shall have responsibility for providing design revision. The CA shall maintain a master deficiency and resolution log, and shall provide the PM with written progress reports and test results with recommended actions.

3.6.1 Procedure

All deficiencies or nonconformance issues shall be noted and reported to the PM on a standard nonconformance form. The CG shall report in writing to the CA and PM weekly, or at a minimum as often as Cx meetings are being scheduled, concerning the status of each apparent outstanding discrepancy identified during Cx. The report shall include explanations of any disagreements and proposals for their resolution, and a copy shall be included in the deficiency report and resolution record. Corrections of minor deficiencies may be made during the tests at the discretion of the CA, and the deficiency and resolution shall be documented on the test procedure form.

3.6.1.1 Non-Disputed Deficiencies

When a deficiency is identified, the CA shall discuss the issue with the CG. When there is no dispute on the deficiency and the CG accepts responsibility to correct it, the CA shall document the deficiency, the adjustments or alterations required to correct it, and the CG's response and intentions. The next test or sequence may then be performed. After the day's work, the CA shall submit all the nonconformance reports to the PM for signature. Copies shall be provided to the CG and PM. The CG shall correct the deficiency, sign the statement of correction at the bottom of the nonconformance form certifying that the equipment is ready to be retested and shall send it back to the CA. The CA shall reschedule the test and the test shall be repeated as specified in the paragraph Retesting.

3.6.1.2 Disputed Deficiencies

If there is a dispute about a deficiency, regarding whether it is a

deficiency or who is responsible, the deficiency shall be documented on the nonconformance form with the CG's response and a copy given to the PM and CG. Resolutions shall be made at the lowest management level possible. Additional parties shall be brought into the discussions as needed. Final interpretive and acceptance authority is with the PM. The CA shall document the resolution process. Once the interpretation and resolution have been decided, the CG shall correct the deficiency, sign the statement of correction on the nonconformance form and provide it to the CA. The CA shall reschedule the test and the test shall be repeated as specified in the paragraph Retesting.

3.6.2 Retesting

The cost to retest a prefunctional test or FT shall be solely the responsibility of the CG. Any required retesting by the CG shall not be considered a justified reason for a claim of delay or for a time extension by the CG. The CA and PM representative shall witness retesting as necessary until satisfactory performance is achieved.

3.6.3 Failure Due to Manufacturer Defect

If the greater of 10 percent of, or three, identical pieces of equipment (size alone does not constitute a difference) fail to perform to the Contract documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the PM. In such case, the CG shall provide the PM with the following:

- a. Within one week of notification from the PM, the CG or manufacturer's representative shall examine all other identical units making a record of the findings.
- b. Within two weeks of the original notification, the CG or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation. The PM shall determine whether a replacement of all identical units or a repair is acceptable.
- c. Two examples of the proposed solution shall be installed by the CG and the PM shall be allowed to test the installations for up to one week, upon which the PM will decide whether to accept the solution.
- d. Upon acceptance, the CG and manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

3.6.4 Deficiency Report and Resolution Record

The CA shall submit original nonconformance forms with the deficiency report and resolution record at the end of the project. The deficiency report and resolution record shall contain documented items of nonconformance in materials, installation, or operation, including the master deficiency and resolution log, and documented results from startup, PCs, FT, and short-term diagnostic monitoring, as specified. Details of

the components or systems found to be noncompliant with the drawings and specifications shall be included. Adjustments and alterations performed or required to correct the deficiencies and the responsible parties shall be identified.

3.7 DEFERRED TESTING

3.7.1 Unforeseen Deferred Tests

If any check or test cannot be completed due to the building structure, required occupancy condition, or other deficiency, a request for delay execution of checklists and FT may be delayed contingent on approval of the PM. These tests shall be conducted as soon as possible in the same manner as seasonal testing.

3.7.2 Seasonal Testing

The CA shall schedule, coordinate, and observe additional testing for seasonal variation in operations and control strategies during the opposite season to verify performance of the HVAC system and controls. The CG shall execute and document tests and correct deficiencies with facilities staff and the CA and PM witnessing. Testing shall be completed during the warranty period to fully test all sequences of operation. The CG shall make necessary revisions to O&M manuals and records due to the testing.

3.7.3 Short-Term Diagnostic Testing

After initial occupancy, the CG shall perform short-term diagnostic testing, using data acquisition equipment or the building automation system to record system operation over a two- to three-week period. The dynamic interactions between components in the building system shall be investigated. The scheduling, interaction between heating and cooling, and effectiveness of the HVAC system in meeting the comfort requirements a design conditions shall be evaluated. The CG shall document tests and findings, and correct deficiencies according to the original testing requirements.

3.8 REVIEW AND APPROVAL

The CA shall validate that the testing requirements of this Contract are accomplished, and shall note each satisfactorily demonstrated function on the test form. Formal approval of the FT shall be made after review by the A/E, CA and PM. The CA shall evaluate each test and report to the PM and A/E using a standard form. The PM and A/E shall give final approval on each test using the same form, and provide signed copies to the CA and the CG.

-- End of Section --



REQUEST FOR PROPOSAL



APPENDIX-II

SAMPLE COMMISSIONING PLAN

01 FEB 07

Commissioning Plan Document for LEED Fundamental Commissioning

Project: _____

Owner Contact: _____

Date: _____

Overview

The purpose of this document is to identify the scope, strategies and responsibilities for all of the team members within the commissioning process for each phase of the project. It outlines the overall process, schedule, organization, responsibilities and documentation for the commissioning process.

The Commissioning Plan Document is a required document for LEED Version 3.0 EA Prerequisite 1, Fundamental Commissioning of the Building Energy Systems. This template contains the basic recommended components indicated in the LEED v3.0 Reference Guide for EA Prerequisite 1, Fundamental Commissioning of the Building Energy Systems. It **does not** include the added components required for EA Credit 3 Enhanced Commissioning. It should be adapted as needed to suit the project, remaining reflective of the LEED intent.

Use of this template is not required, nor are there any restrictions on editing of it. It is provided simply as a tool to assist project teams in meeting the documentation requirements for LEED Fundamental Commissioning.

This template has not been coordinated with the requirements of ASHRAE Guideline 1, The HVAC Commissioning Process. If compliance with ASHRAE Guideline 1 is required, this document must be edited as needed to comply.

The Commissioning Plan Document is typically completed by the Commissioning Authority (CxA). LEED also permits the DOR or the GC to complete the commissioning plan. Per the LEED v3.0 Reference Guide, for Fundamental Commissioning the CxA shall have documented CxA experience in at least two building projects and shall be independent of the project's design and construction management, except that for projects less than 50,000 gross square feet the CxA may include qualified persons on the design or construction teams.

The Commissioning Plan Document should ideally be developed at the start of design and updated throughout the course of the project. It must be completed prior to the approval of Contractor submittals of any commissioned equipment or systems to meet LEED requirements.

Updates to the Commissioning Plan Document throughout the course of project delivery shall be made by the CxA based on decisions and agreements coordinated with and agreed to by the Installation/User/Proponent.

The Commissioning Plan Document shall be included in the project's LEED documentation file under EA PR1, Fundamental Commissioning of the Building Energy Systems.

01 FEB 07

Generally commissioning should start at the beginning of the design development phase. For smaller, less complex projects, the commissioning effort could wait until the beginning of the construction documents phase.

Table of Contents

1. Commissioning Program Overview
 - 1.1 Goals and Objectives
 - 1.2 Abbreviations and Definitions
 - 1.3 Building Information
 - 1.4 Systems to be Commissioned
2. Commissioning Team Members, Roles and Responsibilities
 - 2.1 Commissioning Team
 - 2.1.1 Owner
 - 2.1.2 Not Used
 - 2.1.3 Commissioning Authority (CxA)
 - 2.1.4 Commissioning Team Members
 - 2.2 Roles and Responsibilities
 - 2.2.1 General
 - 2.2.2 Roles and Responsibilities
 - 2.3 Communication Protocol, Coordination, Meetings and Management
 - 2.3.1 Coordination of Commissioning During Design
 - 2.3.1.1 Meetings
 - 2.3.2 Coordination of Commissioning During Construction
 - 2.3.3 Communication Protocols
3. Commissioning Tasks
 - 3.1 Overview of Commissioning Tasks
 - 3.2 Description of Commissioning Tasks
 - 3.2.1 Owner's Project Requirements
 - 3.2.2 Basis of Design
 - 3.2.3 Commissioning Specification Development
 - 3.2.4 Review of Drawings and Specifications

01 FEB 07

- 3.2.4.1 Commissioning Facilitation
- 3.2.5 Pre-functional Checklists, Tests and Startup
 - 3.2.5.1 Startup Plan
 - 3.2.5.2 Execution of Checklists and Startup
 - 3.2.5.3 Sampling Strategy for CxA Observation of Pre-functional Checkout and Startup
 - 3.2.5.4 Deficiencies and Non-conformance
 - 3.2.5.5 Phased Commissioning
 - 3.2.5.6 TAB
 - 3.2.5.7 Controls Checkout Plan
- 3.2.6 Development of Functional Test and Verification Procedures
 - 3.2.6.1 Overview
 - 3.2.6.2 Scope of Testing
 - 3.2.6.3 Development Process
 - 3.2.6.4 Testing Plan Overview
- 3.2.7 Functional Testing
 - 3.2.7.1 Overview and Process
 - 3.2.7.2 Deficiencies and Retesting
 - 3.2.7.3 Facility Staff and DOR Participation
 - 3.2.7.4 Sampling
- 3.2.8 O&M Manuals and Warranties
 - 3.2.8.1 Standard O&M Manuals
- 3.2.9 Training and Orientation of Owner Personnel
- 3.2.10 Commissioning Record
- 3.2.11 Summary Report
- 3.3 Warranty Period Activities
- 4. Schedule
 - 4.1 Design Phase Schedule
 - 4.2 Construction Phase Schedule

APPENDIX

Appendix 1 Example Fire and Emergency Power Response Matrix
(edit attached example as needed)

01 FEB 07

1. Commissioning Program Overview

1.1 Goals and Objectives

Commissioning (Cx) is a systematic process of ensuring that all the building's energy related systems are installed and calibrated and perform interactively according to the design intent and the owner's project requirements and operational needs. This is achieved by beginning at the design phase with documented design and operating intent and continuing through construction and acceptance with actual verification of performance.

Commissioning during design is intended to achieve the following specific objectives:

- Ensure that the design and operational intent are clearly documented.
- Ensure that recommendations are communicated to the design team during design to aid the development of commissioning and avoid later contract modifications.
- Ensure that commissioning for the construction phase is adequately reflected in the construction documents.

Commissioning during the construction of this project is intended to achieve the following specific objectives:

- Ensure that applicable equipment and systems are installed properly and receive adequate operational checkout by installing contractors.
- Verify and document proper performance of equipment and systems through normal and other likely operational modes necessary to meet design intent.
- Ensure that O&M documentation provided to Owner is complete.
- Ensure that the Owner's operating personnel are adequately trained.

1.2 Abbreviations and Definitions

The following are common abbreviations used in this document.

BOD	Basis of Design	Designer of Record	FT	Functional Performance Test
CxA	Commissioning Authority		GC	General Contractor
CC	Controls Contractor		IPM	Installation Project Manager
Cx	Commissioning		MC	Mechanical Contractor
Cx Plan	Commissioning Plan Document		PC	Pre-functional Checklist
DA	Design Agent (Govt)		PE	Project Engineer (Govt)
DOR	Designer of Record		PM	Project Manager (Govt)
EC	Electrical Contractor		Subs	Subcontractors to General
FM	Facility Manager		TAB	Test and Balance Contractor
HVAC	Heating, Ventilating and Air Conditioning		USACE	U.S. Army Corps of Engineers
HVAC&R	Heating, Ventilating, Air Conditioning and Refrigeration		USER	Facility User/Occupant

01 FEB 07

1.3 Building Information

Project Name: _____

Location: _____

Building Type (office, court, etc.): _____

Square Footage: _____ Expected number of stories: _____

Agency: _____ Tenants: _____

Design Period: _____ Const. Period: _____

1.4 Systems to be Commissioned

The following checked systems will be commissioned in this project:

(Systems marked with “”, if provided, must be commissioned to meet LEED requirement)*

- ☐ HVAC&R system (virtually all equipment)
- ☐ *HVAC&R system (primary equipment only)
- ☐ *Passive HVAC&R system: _____
- ☐ *HVAC controls
- ☐ EMCS interface
- ☐ Indoor air quality (moderate level of effort)
- ☐ Indoor air quality (rigorous level of effort)
- ☐ *Automatic Lighting controls
- ☐ *Daylighting controls
- ☐ Electrical system power quality, grounding, etc.
- ☐ Emergency power system
- ☐ UPS systems
- ☐ Communications system (i.e. public address, intercom): _____
- ☐ Security system
- ☐ Fire/smoke alarm and control system
- ☐ *Domestic hot water system
- ☐ *Electronic plumbing sensors
- ☐ Plumbing systems
- ☐ Telecommunications and data systems
- ☐ *Renewable energy system (i.e. wind, solar, geothermal, low-impact hydropower, bio-gas, bio-mass): _____
- ☐ Building envelope
- ☐ Irrigation system
- ☐ Gray water system
- ☐ Rainwater harvesting system
- ☐ Water treatment system
- ☐ Well pumps/sump pumps

01 FEB 07

- ___ Fire protection/suppression systems
- ___ Refrigerant/other leak detection systems
- ___ Toxic fume monitoring systems
- ___ Automatic doors and gates, electronic access control/locking systems
- ___ _____
- ___ _____

01 FEB 07

2. Commissioning Team Members, Roles and Responsibilities

2.1 Commissioning Team

The members of the commissioning team consist of the CxA, PM, IPM, assigned members of the PE, GC, DOR (particularly the mechanical engineer), the mechanical contractor, electrical contractor, TAB representative, controls contractor, any other installing subcontractors or suppliers of equipment. If known, the Owner's building or plant operator/ engineer is also a member of the commissioning team.

2.1.1 Owner

Typically on an Army Installation, the facilities are owned, maintained and operated by the Installation. The User is the building occupant and may change over time. If the facility is an Army Standard Design, the Installation has limited permission to revise features of the Army Standard Design, and the Facility Design Team for that standard design, which includes members from ACSIM, IMA, the Army Proponent and USACE, is the primary Owner from a functional and use standpoint. A significant element of Army Standard Designs is their provision of consistent functional features at all Army Installations, which supports unit mobility between Army Installations. The development of Owner requirements for a particular facility, therefore, requires the combined, coordinated contributions of potentially several entities.

In some instances, Tenant organizations on an Army Installation have agreement with the Installation whereby the Tenant organization maintains and operates its facilities with limited Installation input. Examples of these are SOF, DoDMedical, AAFES. For Tenant facilities the role of Owner shifts with Installation input reduced in accordance with Installation/Tenant agreements.

___ This project is an Army Standard Design and the Owner is the Army Facility Design Team for this standard with support from the Installation.

___ This project is not an Army Standard Design and the Owner is the Installation with support from the User.

___ This project is for an Army Installation tenant that maintains its own facilities and the Owner is the Tenant organization PM with support from the Installation.

2.1.2 Not Used

2.1.3 Commissioning Authority (CxA)

This project ___ has design and construction responsibility in one USACE district
___ has design responsibility and construction responsibility in separate USACE districts.

01 FEB 07

During the design phase, the CxA for this project is

- ☐ an employee of the USACE District who is not on the DOR team
- ☐ an employee of the USACE District who is on the DOR team (facility is less than 50,000 gross square feet)
- ☐ an employee or consultant of the DOR firm who is not on the DOR team
- ☐ an employee or consultant of the DOR firm who is on the DOR team (facility is less than 50,000 gross square feet)
- ☐ an employee or consultant of the Design-Build Contractor who is not on the Construction Team installing the systems.
- ☐ a member of the Design-Build Contractor's Construction Team (facility is less than 50,000 gross square feet)
- ☐ other: _____

During construction phase, the CxA for this project is

- ☐ the same as the CxA for the design phase
- ☐ an employee of the USACE District who is not on the DOR team
- ☐ an employee of the USACE District who is on the DOR team (facility is less than 50,000 gross square feet)
- ☐ an employee or consultant of the DOR firm who is not on the DOR team
- ☐ an employee or consultant of the DOR firm who is on the DOR team (facility is less than 50,000 gross square feet)
- ☐ an employee or consultant of the Design-Build Contractor who is not on the Construction Team installing the systems.
- ☐ a member of the Design-Build Contractor's Construction Team (facility is less than 50,000 gross square feet)
- ☐ an employee or consultant of the Construction Contractor who is not on the Construction Team installing the systems.
- ☐ a member of the Construction Contractor's Construction Team (facility is less than 50,000 gross square feet)
- ☐ other: _____

☐ The following CxA responsibilities during construction phase will be delegated:

01 FEB 07

2.1.4 Commissioning Team Members

Team Member	Co. & Contact Names	Voice, office, cell, fax, email, address
Owner		
USACE Project Manager		
Installation Project Manager		
Property Manager		

USACE Project Engineer		
General Site Contact		
Mechanical		
General Contractor		
Site Supervisor		
Site Coordinator		
Commissioning Authority		
Design		
Construction		
Architect		
Mechanical Designer/Eng.		
Electrical Designer/Eng.		
Tenant Representative		
Mechanical Contractor		
HVAC Site Superv.		
Piping Contractor		
Sheet Metal Contractor		

01 FEB 07

Electrical Contractor Site Supervisor		
TAB Contractor		
Controls Contractor Project Manager Project Engineer		

2.2 Roles and Responsibilities

2.2.1 General

General descriptions of the commissioning roles are as follows:

- CxA: Coordinates the Cx process, develops and updates Cx Plan, assist, reviews and approves incorporation of commissioning requirements in construction documents. Writes or approves tests, oversees and documents performance tests. Develops Commissioning Report.
- PE: Facilitates the Cx process. Coordinates between GC and CxA. Approves test plans and signs-off on performance. Performs construction observation, approves O&M manuals (design-bid-build contracts).
- GC: Facilitates the Cx process, ensures that Subs perform their responsibilities and integrates Cx into the construction process and schedule
- Subs: Demonstrate proper system performance
- DOR: Develops and updates Basis of Design, incorporates commissioning requirements in construction documents. Performs construction observation, approves O&M manuals (design-build contracts) and assists in resolving problems
- PM: Facilitates and supports the Cx process
- Mfr.: The equipment manufacturers and vendors provide documentation to facilitate the commissioning work and perform contracted startup

01 FEB 07

2.2.2 Roles and Responsibilities

Detailed roles and responsibilities for this project's commissioning tasks are indicated in the following table:

(Check the boxes to indicate responsible parties for each task – highlighted boxes indicate the most common designations. Revise narrative as needed to reflect designations)

Commissioning Tasks and Responsibilities														
Responsibility of														Task
Commissioning Plan														
DA	DOR	CA	PM	IPM	USER	FM	PE	GC	TAB	CC	MC	EC	Subs	
														Prepare and update
														Coordinate input from involved parties
														Review and approve (incl updates)
														Provide to AE at start of design
														Provide to PE at start of construction
Owners Project Requirements														
DA	DOR	CA	PM	IPM	USER	FM	PE	GC	TAB	CC	MC	EC	Subs	
														Prepare and update
														Coordinate input from involved parties
														Participate in development/updates
														Review and approve (incl updates)
														Provide to AE at start of design
Basis of Design Document														
DA	DOR	CA	PM	IPM	USER	FM	PE	GC	TAB	CC	MC	EC	Subs	
														Prepare and update
														Coordinate input from involved parties
														Review and approve (incl updates)
Commissioning Specifications														
DA	DOR	CA	PM	IPM	USER	FM	PE	GC	TAB	CC	MC	EC	Subs	
														Prepare and update
														Review and approve (incl updates)
Design Reviews for Commissioning														
DA	DOR	CA	PM	IPM	USER	FM	PE	GC	TAB	CC	MC	EC	Subs	
														Review and approve (incl updates)

01 FEB 07

Prefunctional Checklists, Testing & Startup														
DA	DOR	CA/CS	PM	IPM	USER	FM	PE	GC	TAB	CC	MC	EC	Subs	
														Coordinate schedule
														Prepare prefunctional checklists
														Review and approve checklists (incl updates)
														Execute prefunctional tests
														Witness prefunctional tests
														Verify prefunctional tests and startup are complete
TAB														
DA	DOR	CA/CS	PM	IPM	USER	FM	PE	GC	TAB	CC	MC	EC	Subs	
														Coordinate schedule
														Prepare and submit plan
														Review plan
														Ensure TAB/CC plan coordination
Controls Checkout														
DA	DOR	CA/CS	PM	IPM	USER	FM	PE	GC	TAB	CC	MC	EC	Subs	
														Coordinate schedule
														Prepare and submit plan
														Review plan
														Ensure TAB/CC plan coordination
Functional Testing														
DA	DOR	CA/CS	PM	IPM	USER	FM	PE	GC	TAB	CC	MC	EC	Subs	
														Coordinate schedule
														Develop functional test procedures
														Develop Testing Plan Overview
														Execute tests
														Witness tests
														Document test results
O&M Manuals & Warranties														
DA	DOR	CA	PM	IPM	USER	FM	PE	GC	TAB	CC	MC	EC	Subs	
														Include requirements in specifications
														Review specifications
														Prepare submittals
														Review submittals
														Assemble approved submittals
														Coordinate transfer to Facility Manager

[illegible]

2.3.1 Coordination of Commissioning During Design

The PM will be the coordinator of the commissioning activities during design. The CxA for the design phase makes any necessary clarifications and changes to the original Commissioning Plan. This final plan guides the commissioning work during design. Necessary adjustments to the DOR fees relative to Commissioning Plan changes are negotiated.

01 FEB 07

2.3.1.1 Meetings

The PM will be the coordinator of the commissioning meetings during design. A kick-off meeting will be held with the design team at the beginning of ____ *Conceptual Design Phase*, ____ *Design Development Phase*, ____ *Construction Documents Phase*. This meeting is held after the Cx Plan has been finalized. The meeting includes reviewing the process and outlining each party's responsibilities. This meeting ____ may ____ may not be combined with a larger meeting agenda.

Design review conferences will include an agenda item for commissioning if the CxA or the DOR asks the PM to place it on the meeting agenda. The CxA will attend all design review meetings that include an agenda item for commissioning.

2.3.2 Coordination of Commissioning During Construction

In general, the CxA coordinates the commissioning activities and reports to the ____ PE, ____ GC, ____ DOR. The CxA's responsibilities, along with all other contractors' commissioning responsibilities are detailed in the specifications. The Specifications will take precedence over this Cx Plan. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.

2.3.3 Communication Protocols

The following protocols will be used on this project.

<u>Issue</u>	<u>Protocol</u>
For requests for information (RFI) or formal documentation requests:	Design: The CxA goes through the PM. Construction: The CxA goes through the PE.
For minor or verbal information and clarifications:	The CxA goes direct to the informed party.
For notifying contractors of deficiencies:	Design: The CxA documents deficiencies through the PM. Construction: The CxA documents deficiencies through the PE, but may discuss deficiency issues with contractors prior to notifying the PE.
For scheduling functional tests or training:	____ The CxA may provide input for and do some coordination of training and testing, but does not do any scheduling.
For scheduling commissioning meetings:	Design: The PM selects the date and schedules meetings. Construction: The CxA selects the date and schedules through the: ____ PE, ____ GC.
For making a request for significant changes:	The CxA has no authority to issue change orders.
For making small changes in specified sequences of operations:	____ The CxA may make small sequences of operations changes to improve efficiency or control or to correct deficiencies, through the responsible contractor, but shall document the change and provide all changes of specified sequences to the PE and A/E. ____ The CxA may <u>not</u> make changes to specified sequences without approval from the DOR.
Subcontractors disagreeing with requests	Try and resolve with the CxA first. Then work through GC who will

01 FEB 07

or interpretations by the CxA shall:

work with CxA directly or through the PE to resolve the situation.

3. Commissioning Tasks

3.1 Overview of Commissioning Tasks

The following tasks comprise the commissioning work:

(Tasks marked with “” are required for LEED 3.0 EAPR1 Fundamental Commissioning)*

1. *Develop Owner’s requirements documentation.
2. *Develop Basis of Design documentation
3. Perform a review of Design Development
5. *Develop commissioning specifications for the construction bid documents
6. Perform a final review of the drawings and specifications
7. *Prepare and execute pre-functional checklists, tests and startup
8. *Develop functional test and verification procedures
9. *Execute functional testing
10. Review O&M manuals and warranties
11. Verify training and orientation of Owner personnel
12. *Compile commissioning record
13. *Prepare summary report

3.2 Description of Commissioning Tasks

3.2.1 Owner’s Project Requirements

The Design Agent (DA) shall develop the Owner’s Project Requirements Document. The Owner’s Project Requirements Document is a dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the owner. It is initially the outcome of the programming and conceptual design phases. It covers the following, for each system, major component, facility and area:

- General system description
- Objectives and functional use of the system, equipment or facility
- General quality of materials and construction
- Occupancy requirements
- Indoor environmental quality, IEQ (space temperature, relative humidity, indoor air quality, noise level, illumination level, etc.)
- Performance criteria (general efficiency, energy and tolerances of the IEQ objectives, etc.)
- Budget considerations and limitations

01 FEB 07

- Restrictions and limitations of system or facility

Documentation Format and Detail

The format and rigor of the Owner's project requirements documentation will be similar to the example documentation format found in the USACE LEED Owner's Project Requirements Template, available at <http://en.sas.usace.army.mil>, "Engineering Criteria".

3.2.2 Basis of Design

The Designer of Record (DOR) shall develop the Basis of Design (BOD). The basis of design is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the Owner's project requirements. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. Some reiterating of the design intent may be included. The following should be included in the basis of design for major equipment:

- Specific description of systems, components and methods for achieving the design intent objectives. (For example, for a rooftop air conditioning unit include: why this system was chosen above others, details of size, efficiencies, areas served, capacity control details, compressors, coils, dampers, set points, filters, economizers, minimum ventilation control, control type, noise and vibration criteria, tie-in to other systems, sequences of operation under all modes of operation, control strategies, roof curbs, level of screening, etc.)
- Manufacturers' catalog cut-sheets
- Equipment maintainability
- Fire, life, safety: criteria, general strategy narrative and detailed sequences
- Emergency power control and function
- Energy performance
- Ventilation strategies and methods
- Complete sequences of operation, including set points and control parameters
- Schedules
- Applicable codes and standards
- Primary load and design assumptions
 - Diversity used in sizing
 - Occupant density and function
 - Indoor conditions (space temperature, relative humidity, CO2 level, lighting power density, ventilation and infiltration rates, etc.)
 - Outdoor conditions
 - Glazing fraction, U-value and shading coefficient

Information of secondary importance to the commissioning and operation of the building should be documented by the design team, but is not included in the design documentation described here or included in the O&M manuals (e.g., wall R-values, mass, etc.)

The detail of the basis of design increases as the design process progresses. In the beginning, the design documentation required is primarily a narrative of the building

01 FEB 07

system descriptions, the purpose of the systems, how the systems will meet those objectives and why this system or method was chosen above others. As the design process progresses, the design documentation includes a specific description of the system and components, its function, how it relates to other systems, sequences of operation, and operating control parameters.

The basis of design document is not a substitute for what may be required in the specifications or contract.

Basis of Design documentation for other components and systems such as structural, interior design, furnishings, etc. may be required, but are not a part of the commissioning work unless listed and checked herein.

Documentation Format and Detail

The format and rigor of the design intent documentation will be similar to the example documentation format found in the USACE LEED Basis of Design Template, available at <http://en.sas.usace.army.mil>, "Engineering Criteria". The design team follows the example format and level of detail for, at a minimum, the systems checked above in paragraph Systems to be Commissioned.

Submittal and Review

The Basis of Design Document is submitted with each design submittal. The CxA reviews it and comments in DrChecks. The DOR responds to CxA comments through DrChecks.

A copy of the final design submittal basis of design is provided to the commissioning authority at the beginning of construction. A final as-built copy is prepared and is included in the O&M manuals at the end of construction.

Sequences of Operation

Detailed written sequences of operation shall be developed with the following components clearly and completely described for each piece of dynamic equipment:

- An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function
- All interactions and interlocks with other systems
- Detailed delineation of control between any packaged controls and the building automation system (BAS), listing what points the BAS monitors only and what BAS points are control points and are adjustable
- EMCS interface and trend log data
- Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative.)
- Startup sequences
- Warm-up mode sequences
- Normal operating mode sequences
- Unoccupied mode sequences

01 FEB 07

- Shutdown sequences
- Capacity control sequences and equipment staging
- Temperature and pressure control: setbacks, setups, resets, etc.
- Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, CO2 control, humidity control, occupant control, etc.
- Effects of power or equipment failure with all standby component functions
- Sequences for all alarms and emergency shut downs
- Seasonal operational differences and recommendations
- Initial and recommended values for all adjustable settings, set points and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment
- Schedules, if known
- All sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.
- The CxA shall monitor equipment selection during the construction phase and shall update the Sequences of Operation to reflect the selection of dynamic equipment whose sequences differ from the sequences assumed as the basis of design.

Fire and Emergency Power Response Matrix

An HVAC fire and emergency power response matrix that lists all equipment and components (air handlers, dampers, valves, etc.) with their status and action during a fire alarm and under emergency power shall be developed. An example of a fire and power response matrix and flow chart are found in Appendix 1.

3.2.3 Commissioning Specification Development

Commissioning specifications for inclusion in the construction bid documents are developed by members of the design team as part of the commissioning process during design. The CxA may participate in commissioning specification development.

Purpose

The commissioning specifications provide the requirements and process for properly executing the commissioning work.

Specification Content

The commissioning specifications shall provide a clear description of the extent of the verification testing required, including what components and systems will be tested and the documentation, reporting and scheduling requirements. Details of the extent of testing and who is responsible for writing tests, executing tests, witnessing and signing-off on tests shall be included. The relationship between and requirements for start-up, pre-functional checklists, manual functional performance tests, control system trend

01 FEB 07

logs and stand-alone data logging shall also be given. Example pre-functional and functional tests shall be included in the specifications. The specifications shall also detail the operator training and the O&M documentation and any O&M plan requirements. Any specific program of tasks focusing on indoor air quality shall be included in the specifications.

Coordination, Reporting and Review

The DOR is responsible for developing the individual sections of the commissioning specifications and coordinates the commissioning specification effort.

3.2.4 Review of Drawings and Specifications

(CxA review of design documents is recommended but is not a requirement for LEED 3.0 EAPR1 Fundamental Commissioning)

The commissioning authority, along with the traditional design team members, reviews the full set of Construction Documents and specifications when approximately 50% and 95% complete.

The PM ensures the CxA is included in distribution of design submittals.

The commissioning authority compares the design with the interests and needs of the Owner as identified in the Owners Project Requirements document. The CxA also reviews the submittal with respect to the design areas checked in the table below, exercising the level of rigor checked in the table below.

The commissioning authority reviews the specifications and comments in DrChecks. The DOR responds to CxA comments through DrChecks. Closing of all CxA comments indicates CxA approval.

The commissioning authority review does not include review for design concept, design criteria or compliance with codes. The commissioning authority does not *verify* the designers' calculations or proof schematics or layouts in detail. The constructability review is performed by another party. For example, the commissioning authority does not verify appropriate pipe or duct sizing, but may provide comments on unusually tight or restrictive duct layouts and bends or a poor location of a static pressure sensor.

Though the commissioning authority coordinates and reviews the commissioning specifications, the ultimate responsibility for their content and preparation lies with the DOR.

Table 5-3. Commissioning Authority Drawing and Specification Review

Design Area	Review Description	Rigor
___ Commissioning facilitation	Input regarding making the building easier to commission (see Commissioning Facilitation below)	___moderate ___rigorous

01 FEB 07

Design Area	Review Description	Rigor
___ Component energy efficiency	Review for adequacy of the efficiency of bldg. shell components, HVAC systems and lighting systems.	___ moderate ___ rigorous
___ Control system & control strategies	Review ___ HVAC, ___ lighting, ___ fire control, ___ security control system, strategies and sequences of operation for adequacy and efficiency.	___ moderate ___ rigorous
___ Operation and maintenance	Review for effects of specified systems and layout toward facilitating O&M (equipment accessibility, system control, etc.).	___ moderate ___ rigorous
___ Indoor environmental quality ¹	Review to ensure that systems relating to ___ thermal, ___ visual, ___ acoustical, ___ air quality comfort, ___ air distribution are in accordance with the design intent.	___ moderate ___ rigorous
___ Environmental sustainability	Review to ensure that the ___ building materials, ___ landscaping, ___ use of water resources, ___ waste management are in accordance with the design intent.	___ moderate ___ rigorous
___ Facility performance and design intent	Identify flaws, oversights, or insufficient detail in the design, relevant to being able to reasonably meet the design intent	___ moderate ___ rigorous
___ Functionality for tenants	Review to ensure that the design meets the functionality needs of the tenants.	___ moderate ___ rigorous
___ Life cycle costs	Perform a ___ qualitative, ___ quantitative lifecycle assessment of the primary competing systems relative to ___ energy efficiency, ___ O&M, ___ IEQ, ___ functionality.	___ moderate ___ rigorous
___ O&M documentation	Verify that building O&M plan and documentation requirements specified are adequate	___ moderate ___ rigorous
___ Training	Verify that operator training requirements specified are adequate.	___ moderate ___ rigorous
___ Commissioning specifications	Verify that bid documents adequately specify building commissioning and that there are adequate monitoring and control points specified to facilitate commissioning and O&M (trending capabilities, test ports, control points, gages and thermometers).	___ moderate ___ rigorous
___ Review of engineering assumptions	Review the engineering assumptions relating to equipment sizing, energy efficiency decisions and HVAC cost-benefit calculations	___ moderate ___ rigorous
___ Owner's design guide or standard	Verify that the design complies with the Owner's own design standard or guideline.	___ moderate ___ rigorous

3.2.4.1 Commissioning Facilitation

One of the primary tasks for the commissioning authority is reviewing the design documents to facilitate commissioning during construction. Many of the features that facilitate commissioning will also enhance ease of building operation. All items from the list below shall be considered for incorporation into the project.

01 FEB 07

If Commissioning Facilitation is checked in the table above, CxA design submittal reviews will include the following:

1. Clear and rigorous design documentation, including detailed and complete sequences of operation.
2. An HVAC fire and emergency power response matrix that lists all equipment and components (air handlers, dampers, valves, etc.) with their status and action during a fire alarm and under emergency power (Appendix 1 example to be edited for project).
3. Access for reading gages, entering doors and panels, observing and replacing filters, coils, etc.
4. Required isolation valves, dampers, interlocks, piping, etc. to allow for manual overrides, simulating failures, seasons and other testing conditions.
5. Sufficient monitoring points in the building automation system (BAS), even beyond that necessary to control the systems, to facilitate performance verification and O&M.
6. Adequate trending and reporting features in the BAS, EMCS graphics.
7. Pressure and temperature (P/T) plugs close to controlling sensors for verifying their calibration.
8. Pressure gages, thermometers and flow meters in strategic areas for verifying system performance and ongoing O&M.
9. Pressure and temperature (P/T) plugs at less critical areas or on smaller equipment where gages and thermometers would be over-kill.
10. Specification of the location and criteria for the VAV duct static pressure sensor and chilled water and/or hot water differential pressure sensor.
11. Adequate balancing valves, flow metering and control stations and control system functions to facilitate and verify reliable test and balance.
12. Uniform inlet connection requirements to VAV terminal boxes.
13. Clear and complete commissioning specifications for the construction phase.
14. Complete O&M documentation requirements in the specifications.
15. Complete training requirements in the specifications.
16. Review entire document and building information management plan from design through construction and turnover to ensure adequacy and compliance with the owner's program.

3.2.5 Pre-functional Checklists, Tests and Startup

Pre-functional checklists (PC) are important to ensure that the equipment and systems are hooked up and operational and that functional performance testing may proceed without unnecessary delays. Each piece of equipment receives full pre-functional checkout by the Contractor. No sampling strategies are used. In general, the pre-functional testing for a given system, must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

01 FEB 07

Pre-functional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., oil levels OK, fan belt tension, labels affixed, gages in place, sensor calibration, etc.). However, some pre-functional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). The word pre-functional refers to before functional testing. Pre-functional checklists augment and are combined with the manufacturer's start-up checklist.

The CxA does not witness much of the pre-functional check-listing, except for testing of larger or more critical pieces of equipment and some spot-checking.

3.2.5.1 Start-up Plan

A. ____ The following procedures will be used for this project: (the CxA is responsible for the plan development):

1. The CxA adapts and enhances, if necessary, the example pre-functional checklists (PC) and procedures, and develops original lists, as necessary.
2. The CxA obtains manufacturer installation, startup and checkout data, including actual field checkout sheets used by the field technicians from the contractor (through an RFI).
3. The CxA copies all pages with important instructional data and procedures from the startup and checkout manuals not covered in manufacturer field checkout sheets and adds a signature line in the column by each procedure.
4. The copied pages from (2), along with the pre-functional checklist provided by the CxA and the manufacturer field checkout sheets become the "Startup and Checkout Plan."
5. For systems that may not have adequate manufacturer startup and checkout procedures, particularly for components being integrated with other equipment, the Sub provides the added necessary detail and documenting format to the CxA for approval, prior to execution.
6. The CxA transmits the full Startup Plan to the GC, who designates which trade or contractor is responsible to fill out each line on the Pre-functional Checklist from the CxA. The GC then transmits the full start-up plan to the Subs for their review and use. (This usually means that the Pre-functional Checklist, alone, will go to more than one Sub, while the full plan will go to the primary installing contractor.)

–OR–

B. ____ The following procedures will be used for this project: (the Sub is responsible for the plan development):

1. The CxA adapts and enhances, if necessary, the example pre-functional checklists (PC) and procedures and develops original lists, as necessary.

01 FEB 07

2. The CxA transmits them to the GC who designates which trade or contractor is responsible to fill out each line item on the Pre-functional Checklist from the CA. The GC then transmits the checklist to the responsible Subs.
3. The Sub designated to develop the Start-up Plan obtains manufacturer installation, start-up and checkout data, including actual field checkout sheets used by the field technicians.
4. The Sub copies all pages with important instructional data and procedures (not covered in manufacturer field checkout sheets) from the start-up and checkout manuals and adds a signature line in the column by each procedure.
5. The copied pages from (2), along with the pre-functional checklist provided by the GC (originally from the CxA) and the manufacturer field checkout sheets become the “Start-up and Checkout Plan.”
6. For systems that may not have adequate manufacturer start-up and checkout procedures, particularly for components being integrated with other equipment, the Sub should provide the added necessary detail and documenting format to the CxA for approval, prior to execution.
7. The Sub transmits the full Start-up Plan to the CxA for review and approval.
8. The CxA reviews and approves the procedures and the format for documenting them. The GC then transmits the full start-up plan to the Subs for their review and use. (This usually means that the Pre-functional Checklist, alone, will go to more than one Sub, while the full plan will go to the primary installing contractor.)

3.2.5.2 Execution of Checklists and Startup

Four weeks prior to startup, the Subs and vendors schedule startup and initial checkout with the PE, GC and CxA. The startup and initial checkout are directed and executed by the Sub or vendor. The CxA, and PE if necessary, observe, at minimum, the procedures for each piece of primary equipment, unless there are multiple units, when a sampling strategy is used. For components of equipment, (e.g., VAV boxes), the CxA observes a sampling of the pre-functional and start-up procedures.

To document the process of startup and checkout, the site technician performing the line item task initials and dates each paragraph of procedures in the “Startup Plan” and checks off items on the pre-functional and manufacturer field checkout sheets, as they are completed. Only individuals having direct knowledge of a line item being completed shall check or initial the forms.

The Subs and vendors execute the checklists and tests and submit a signed copy of the completed start-up and pre-functional tests and checklists to the CxA. The CxA may review pre-functional checklists in progress, as necessary.

3.2.5.3 Sampling Strategy for CxA Observation of Pre-functional Checkout and Startup

The following table provides a tentative list of the equipment and how much of the pre-functional checkout and startup work will be witnessed by the commissioning authority.

01 FEB 07

<u>Equipment or System</u>	<u>Fraction To Be Observed by CxA</u>
Central plant (chillers, boilers, cooling tower)	50%
Packaged roof top units	50%
Pumps, VFD's	10%
Pipe flushing	At beginning and end
Terminal units	2%
Building automation system	Observe ____ hours of checkout and calibration
TAB work	Observe ____ hours of TAB
Other misc. equipment	As necessary

3.2.5.4 Deficiencies and Non-Conformance

The Subs clearly list any outstanding items of the initial start-up and pre-functional procedures that were not completed successfully at the bottom of the procedures form or on an attached sheet. The procedures form and deficiencies are provided to the CxA within two days of test completion. The CxA works with the Subs and vendors to correct and retest deficiencies or uncompleted items, involving the PE and others as necessary. The installing Subs or vendors correct all areas that are deficient or incomplete according to the checklists and tests. The CxA recommends approval of the startup and initial checkout of each system to the PE.

3.2.5.5 Phased Commissioning

Because of project size, this project ____ will require, ____ will not require startup and initial checkout to be executed in phases.

3.2.5.6 TAB

(CxA review of TAB plan is recommended but is not a requirement for LEED 3.0 EAPR1 Fundamental Commissioning)

The TAB contractor submits the outline of the TAB plan and approach to the CxA and the controls contractor eight weeks prior to starting the TAB. Included in the approach, is an explanation of the intended use of the building control system. The CxA reviews the plan and approach for understanding and coordination issues and may comment, but does not "approve." The controls contractor reviews the feasibility of using the building control system for assistance in the TAB work. The TAB submits weekly written reports of discrepancies, contract interpretation requests and lists of completed tests to the CxA and PE. This facilitates quicker resolution of problems and will result in a more complete TAB before functional testing begins.

TAB work will not begin until the control system has been pre-functionally tested and selective functional tests have been performed and approved by the CxA.

01 FEB 07

3.2.5.7 Controls Checkout Plan

The controls contractor develops and submits a written step-by-step plan to the CxA which describes the process they intend to follow in checking out the control system and the forms on which they will document the process. The controls contractor will also meet with the TAB contractor prior to the start of TAB and review the TAB plan to determine the capabilities of the control system for use in TAB. The controls contractor will provide the TAB with any necessary unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.). The controls contractor shall also provide a technician qualified to operate the controls to assist the TAB contractor in performing TAB. All CxA-required controls pre-functional checklists, calibrations, start-up and selected functional tests of the system shall be completed and approved by the CxA prior to TAB. The controls contractor shall execute the tests and trend logs assigned to them and remain on site for assistance for mechanical system functional tests as specified.

3.2.6 Development of Functional Test and Verification Procedures

3.2.6.1 Overview

Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure set point). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all of the control system's sequences of operation and components are verified to be responding as the sequences state. The CxA develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor.

3.2.6.2 Scope of Testing

The specifications provide specific functional testing scope for each piece of commissioned equipment. A detailed description of the functional and pre-functional testing procedures and process is found in the specifications. If specific testing requirements were not included in the bid documents and original specifications, they should be developed for this project for each piece of commissioned equipment.

3.2.6.3 Development Process

Before test procedures are written, the CxA obtains all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, control sequences and set points. The CxA develops specific test procedures to verify proper operation of each piece of equipment and system, using the testing requirements in the specifications. The CxA obtains clarification, as needed, from contractors and the DOR regarding sequences and operation to develop these tests. Prior to execution, the CxA provides a copy of the primary equipment tests to the installing Sub (via the GC) who reviews the tests for feasibility, safety, warranty and

01 FEB 07

equipment protection. Blank copies of the procedures are input into the O&M manuals for later use by operations staff.

Functional testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The CxA follows the Specifications when given and uses judgment where needed to determine which method is most appropriate. According to the Specifications, not all pieces of identical equipment receive in-depth testing. The CxA reviews owner-contracted, factory or required owner acceptance tests and determines what further testing may be required to comply with the Specifications. Redundancy is minimized.

The specifications indicate the owner-contracted or conducted tests for which the CxA does not write procedures or document execution. Included is the CxA's judgement as to the rigor of the tests and the need for more in-depth testing. The CxA reviews and approves documentation format of these tests prior to execution, but does not develop the procedures or document their execution, unless so requested by the PE.

3.2.6.4 Testing Plan Overview

The GC develops the testing plan overview to provide the contractors with a better idea of where functional testing lies in the schedule, what issues are preventing the start of testing, which contractors are needed for each test and how much time might be expected from them. This is developed after most equipment has been started up and when functional testing dates are not too far off. The testing plan overview is provided to the Contractors to assist in moving more efficiently to functional testing.

3.2.7 Execution of Functional Testing Procedures

3.2.7.1 Overview and Process

The CxA schedules functional tests through the PE, GC and affected Subs. For any given system, prior to performing functional testing, the CA waits until the pre-functional checklist has been submitted with the necessary signatures, confirming that the system is ready for functional testing. The CxA oversees, witnesses and documents the functional testing of all equipment and systems according to the Specifications and the Cx Plan. The Subs execute the tests. The control system is tested before it is used to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems and finally to interlocks and connections between systems. The CxA documents the results of the test.

3.2.7.2 Deficiencies and Retesting

Corrections of minor deficiencies identified are made during the tests at the discretion of the CxA. The CxA records the results of the test on the procedure or test form. Deficiencies or non-conformance issues are noted and reported to the PE. Subs correct deficiencies, notify the CxA and certify correction. The CxA schedules retesting

01 FEB 07

through the PE. Decisions regarding deficiencies and corrections are made at as low a level as possible, preferably between CxA or PE and the Sub. For areas in dispute, final authority resides with the PM. The CxA recommends acceptance of each test to the PE. The PE gives final approval on each test.

3.2.7.3 Facility Staff and DOR Participation

The Owner's facilities operating staff and the DOR are encouraged to attend and participate in the testing process. The CxA will notify the ___PE, ___PM, who will then notify the facility staff/DOR when the commissioning events will occur.

3.2.7.4 Sampling

Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. The Specifications specify the sampling strategies that are used on this project.

3.2.8 O&M Manuals and Warranties

3.2.8.1 Standard O&M Manuals

(CxA review of O&M manuals and equipment warranties is recommended but is not a requirement for LEED 3.0 EAPRI Fundamental Commissioning)

The CxA reviews the O&M manuals, documentation and red line as-builts for systems that were commissioned to verify compliance with the Specifications. The CxA recommends approval and acceptance of these sections of the O&M manuals to the PE. The CxA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated.

3.2.9 Training and Orientation of Owner Personnel

The following training will be provided in this project:

HVAC&R system (all equipment)	___video	___class	___hands-on
HVAC&R system (primary equipt only)	___video	___class	___hands-on
Passive HVAC&R system	___video	___class	___hands-on
HVAC controls	___video	___class	___hands-on
EMCS interface	___video	___class	___hands-on
Indoor air quality (moderate)	___video	___class	___hands-on
Indoor air quality (rigorous)	___video	___class	___hands-on
Automatic Lighting controls	___video	___class	___hands-on
Daylighting controls	___video	___class	___hands-on
Electrical system	___video	___class	___hands-on
Emergency power system	___video	___class	___hands-on
Communications system	___video	___class	___hands-on
Security system	___video	___class	___hands-on
Fire/smoke alarm and control system	___video	___class	___hands-on
Domestic hot water system	___video	___class	___hands-on
Electronic plumbing sensors	___video	___class	___hands-on
Plumbing systems	___video	___class	___hands-on

01 FEB 07

Telecommunications and data systems	___video	___class	___hands-on
Renewable energy system	___video	___class	___hands-on
Building envelope	___video	___class	___hands-on
Irrigation system	___video	___class	___hands-on
Gray water system	___video	___class	___hands-on
Rainwater harvesting system	___video	___class	___hands-on
Water treatment system	___video	___class	___hands-on
_____	___video	___class	___hands-on
_____	___video	___class	___hands-on

3.2.10 Commissioning Record

The CxA will compile, organize and index the following commissioning data by equipment into labeled, indexed and tabbed, three-ring binders and deliver it to the GC, to be included with the O&M manuals. The correspondence, meeting minutes and progress reports, miscellaneous notes, etc. kept in the Commissioning Record Book during construction will not be retained into this record and the O&M manuals. The format of the manual follows:

General

- Tab I-1 Commissioning Plan
- Tab I-2 Final Commissioning Report
- Tab I-3 Issues Log (record of deficiencies)
- Tab I-4 Progress Record

Equipment Specific

- Tab 01 System Type 1 (chiller system, packaged unit, boiler system, etc.)
 - Sub-Tab A Design narrative and criteria, sequences, approvals for Equipment 1
 - Sub-Tab B Start-up plan and report, approvals, corrections, blank pre-functional checklists
 - Colored Separator Sheets—for each equipment type (fans, pumps, chiller, etc.)
 - Sub-Tab C Functional tests (completed), trending and analysis, approvals and corrections, training plan, record and approvals, blank functional test forms and a recommended recommissioning schedule.
- Tab 02 System Type 2.....repeat as per System One

3.2.11 Summary Report

A final summary report by the CxA will be provided to the PE. The report shall include an executive summary, list of participants and roles, brief building description,

01 FEB 07

overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the commissioning authority regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas: 1) Equipment meeting the equipment specifications, 2) Equipment installation, 3) Functional performance and efficiency, 4) Equipment documentation and design intent, and 5) Operator training. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented. The functional performance and efficiency section for each piece of equipment shall include a brief description of the verification method used (manual testing, BAS trend logs, data loggers, EMCS graphicsetc.) and include observations and conclusions from the testing.

Appendices shall contain acquired sequence documentation, logs, meeting minutes, progress reports, deficiency lists, site visit reports, findings, unresolved issues, communications, etc. Pre-functional checklists and functional tests (along with blanks for the operators) and monitoring data and analysis will be provided in a separate labeled binder.

The commissioning plan, the pre-functional checklists, functional tests and monitoring reports will not be part of the final report, but will be stored in the Commissioning Record in the O&M manuals.

A copy of the Commissioning Report will be included in the project's LEED documentation file under EA PR1, Fundamental Commissioning of the Building Energy Systems.

3.3 Warranty Period Activities

During the warranty period, seasonal testing and other deferred testing required is completed according to the Specifications. The CxA coordinates this activity. Tests are executed and deficiencies corrected by the appropriate Subs, witnessed by facilities staff and the CxA. Any final adjustments to the O&M manuals and as-builts due to the testing are made.

4. Schedule

4.1 Design Phase Schedule

The commissioning activities are integrated into the typical design process without any real increase in the timetable of deliverables. Table 4-1 illustrates the location of the commissioning activities during design.

Table 4-1. Commissioning Schedule—Design Phase

Tasks	Programming	Conceptual Development	Design Development	Construction Documents & Specifications
1. Coordination	_____	_____	_____	_____

01 FEB 07

2. Design Phase Cx Plan				
a. Kick-off Meeting				
3. Design Dev. Review				
4. Design Intent Doc.				
5. Construction Cx Plan				
6. Cx Specifications				
7. Drawing & Spec Reviews				

4.2 Construction Phase Schedule

The following sequential priorities are followed:

1. Equipment is not “temporarily” started (for heating or cooling), until pre-start checklist items and all manufacturer’s pre-start procedures are completed and moisture, dust and other environmental and building integrity issues have been addressed.
2. Functional testing is not begun until pre-functional and start-up and TAB is completed, for a given system (this does not preclude a phased approach).
3. The controls system and equipment it controls are not functionally tested until all points have been calibrated and pre-functional testing completed.
4. All CxA-required controls pre-functional checklists, calibrations, start-up and selected functional tests of the system shall be completed and approved by the CxA prior to TAB.
5. TAB is not performed until the envelope is completely enclosed and ceiling complete, unless the return air is ducted.

The initial commissioning schedule is summarized in Table 4-2.

Table 4-2. Construction Commissioning Schedule Summary

Task / Activity	Estimated Start Date	Estimated End Date
Initial scoping meeting and final plan		
Submittals obtained and reviewed		
Begin construction site visits/inspections		
Pre-functional forms developed and distributed		
Startup and initial checkout plans		
Startup and initial checkout executed		

01 FEB 07

TAB	Water Air		
Functional performance tests			
O&M documentation review and verification			
Training and training verification			
Final commissioning report			
Seasonal testing			

01 FEB 07

APPENDIX 1

Fire and Emergency Power Response Matrix

(edit attached document)

01 FEB 07

--SAMPLE--

Fire and Emergency Power Response Matrix

Component	Response to Fire / Smoke Alarm			Response to a Street Power Outage		
	Alarm Type-1: Any Fire Alarm in Bldg ¹ (unless noted)	Alarm Type-2:	Controls to Use & Reset, (Manual, BAS, etc.)	Response	Controls to Use (Manual, BAS, etc.)	Manual Reset Reg'd?
Rooftop units-1,2,3;4:						
Start / Stop	Shutdown		Off--no control. Reset varies: ²	Shutdown	none	No, but smoke dprs must be open
Dampers	Go to normal: OA is closed RA is open EA is closed		na	Go to Normal	none	No
Terminal Units	Dampers: 100% open Valves: no change		na	Dampers: stop where they are Valves: open	none	No
Split FCU-2; ACU-1	none		Normal (manual)	None (go on emergency power)	Normal (manual)	na
BAS	Receive and log an alarm		Normal	None (goes on own battery backup)	Off	na
Exh. Fans EF-1a,b, 2, 3	Off with RTU's		Override in BAS	Off	none	No
Exh. Fans EF-1c; 4	none		Normal	Off	none	Manual Timers
Boiler	none		Normal	Off	none	No
Boiler pumps	none		Normal	Off	none	No
CUH's	none		Normal	Off	none	No
Elevators	<u>Any general alarm</u> : go to 1st floor. <u>SD in elev. shaft or equip. room</u> : go to 2nd floor. <u>SD in front of elev. on 1st floor</u> : go to 2nd floor. <u>Heat det. in shaft or equip. rm.</u> : shunt trip elev. off.		Manual	Lights ON; car stops where it is	none	No
Med-Gas Vac. compr	none		Normal	Off	none	No
Med-Gas Gas compr	none		Normal	Off, but medgas alarm on emerg. gen	none	No
Normal Lighting Sys.	none		Normal	Off	none	No

01 FEB 07

Emerg. Lighting Sys.	none		Normal	None: goes on emerg. power	BAS	nao
Data Management	none		Normal	None: goes on emerg. power+UPS	Normal	na
Paging System	none		Normal	Off	none	No
Security System	Operates per normal, sending alarms		Normal	None: goes on emerg. power + on battery backup	Normal	na
Fire/Smoke Dampers	All close		auto-reset if fusible link didn't release	None: slowly leak down and close	Normal	na
Fire Doors	All close, except OH doors at pharmacy, unless 1 of 3 adjacent clg. SD alarms		manually reset	None: goes on emerg. power + on battery backup	na	na
Emerg. Gen. & UPS	none		na	Goes on-line & alarms to Security	Normal	na
Emerg. Pwr. Circuits	none		na	None: go on emerg. power	Normal	na
Fire Alarm System Functions	normal operation		na	None: goes on emerg. power + on battery backup	Normal	na
Communications to BAS	alarm sent to BAS from FAP		na	None	na	na
Communication to Outside						
Owner's Site	Gets fire and trouble message via Sec. Co.			Gets message via Sec. Co.		
Security Co.	gets fire and trouble message via in-bldg dialer		na	gets message via in-bldg dialer, due to UPS starting`	na	na
Fire Dept.	fire alarm via Sec. Co		na	none	na	na

¹Any Fire Alarm: (pull station, space or duct smoke detector, heat detector or sprinkler flow). This does not include trouble alarms or release of fusible links in fire dampers, or heat detection and smoke detector in elevator shaft or equipment rooms. A smoke detector trip in the elevator shaft or equipment room causes elevator to go to 2nd floor.

²A duct detector trip will cause a general alarm and will shut down all RTU's. Only RTU associated with tripped detector requires manual reset at the RTU panel. On a normal general alarm, all RTU's are automatically reset upon resetting the fire alarm panel.



REQUEST FOR PROPOSAL



APPENDIX-JJ

BASIS OF DESIGN DOCUMENT FOR LEED FUNDAMENTAL COMMISSIONING

01 FEB 07

Basis of Design Document for LEED Fundamental Commissioning

Project: _____

Approved: _____

_____	_____	_____
Name	Design Agent's Representative	Date
_____	_____	_____
Name	Commissioning Authority	Date

Overview and Instructions

The purpose of this document is to provide clear and concise documentation of the Designer's response to the Owner's goals, expectations and requirements for commissioned systems, and shall be utilized in conjunction with the Owner's Project Requirements Document for LEED Fundamental Commissioning throughout the project delivery and commissioning process to provide an informed baseline and focus for design development and for validating constructed systems' energy and environmental performance.

The Basis of Design Document for LEED Fundamental Commissioning is a required document for LEED Version 2.2 EA Prerequisite 1, Fundamental Commissioning of the Building Energy Systems. It shall be completed by the Designer and shall be reviewed and approved by the Design Agent (as Owner's representative) and the Commissioning Authority.

Use of this template is not required, nor are there any restrictions on editing of it. It is provided simply as a tool to assist project teams in meeting the documentation requirements for LEED Fundamental Commissioning.

This template has not been coordinated with the requirements of ASHRAE Guideline 1, The HVAC Commissioning Process. If compliance with ASHRAE Guideline 1 is required, this document must be edited as needed to comply.

The Basis of Design Document for LEED Fundamental Commissioning shall be submitted with each design submittal, updated as design progresses, and submitted complete as part of the final design submittal. It must be completed prior to the approval of Contractor submittals of any commissioned equipment or systems to meet LEED requirements. Subsequent updates to the document will be made as needed during the as-built phase. Development of and all updates to this document shall be made by the

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01 FEB 07

Designer and approved by the Design Agent (as Owners Representative) and the Commissioning Authority.

The intent of the Basis of Design Document for LEED Fundamental Commissioning, per the LEED v2.2 Reference Guide, is to describe the design of systems to be commissioned and outline any design assumptions that are not otherwise included in the design documents. This template contains the basic recommended components indicated in the LEED v2.2 Reference Guide. It shall be adapted as needed to suit the project, remaining reflective of the LEED intent.

The document shall address the primary areas related to energy use and comfort for which the design intent and basis of design should be defined. The design intent provides the explanation of the ideas, concepts and criteria that are considered to be very important to the owner, coming out of the programming and conceptual design phases. The basis of design is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the design intent. The format merges the salient parts of the design intent and basis of design. The design intent evolves from more general descriptors during the conceptual design, to more specific descriptors during actual design, to in-depth and specific descriptors during the specifying stage, which are finalized during the as-built phase. As part of the design narrative, one-line CAD drawings shall be developed for the systems listed in the *Design-Phase Commissioning Plan*.

Under each area or building system is an outline of pertinent questions and data needed. Sequences of operation for all outlined dynamic systems and components should be clearly documented. Attaching equipment manufacturers' sequences may be acceptable, but will generally require additional narrative.

Updates to the Basis of Design Document for LEED Fundamental Commissioning throughout the course of project delivery shall be made by the Designer based on decisions and agreements coordinated with and agreed to by the Design Agent as Owner's representative and the Commissioning Authority.

The Basis of Design Document for LEED Fundamental Commissioning shall be included in the project's LEED documentation file under EA PR1, Fundamental Commissioning of the Building Energy Systems.

01 FEB 07

Basis of Design Document for LEED Fundamental Commissioning

Contents

1. General Building Design, Function and Landscaping
 - Overview
 - Sustainable construction and environmental compatibility
 - Indoor environmental quality—thermal, air distribution, acoustics, air quality, visual quality
 - Landscaping
2. HVAC Systems and Design Parameters
 - Overview
 - Design conditions and load assumptions
3. Chiller System (Chillers, Cooling Towers, Pumps, Piping)
4. Boiler and Heating Water System
5. Roof Top Packaged System(s)
6. VAV Terminal Units – Air Conditioning Only (TU-AC)
7. VAV Terminal Units – Reheat (TU-RH)
8. Heat Recovery Unit (HRU)
9. Computer Room Air Conditioning Unit (CRACU)
10. Daylighting Controls
11. Lighting Sweep Control
12. Building Automation System (BAS)
13. Split Air Conditioning; Heat Pump System
14. Emergency Power System

01 FEB 07

1 **General Building Design, Function, and Landscaping**

1.1 General Building Design and Function

What are the general design objectives regarding energy efficiency?

Comfort and indoor environmental quality?

Sustainability and environmental compatibility?

Other:

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

1.2 Sustainable Construction and Environmental Compatibility

Design Intent

What are the objectives regarding sustainability and environmental compatibility?

01 FEB 07

Basis of Design-General Description and Function

How will the building/grounds systems meet the design intent?

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

1.3 Indoor Environmental Quality***Design Intent***

What are the general objectives for indoor environmental quality?

Thermal Comfort—General Description and Function

Record the occupant activity and design temperatures for the various spaces in Table 1.

Air Distribution

What issues were considered in choosing diffusers?

Is the return air (RA) ducted or open-plenum? Why?

Are the RA grills in every room? Why?

What special considerations are being given to spaces with high solar load regarding cooling, large glazed areas, cold-air convective drafts, etc.? What solutions were used?

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D_INTENT.V08)

01 FEB 07

Acoustics

What is the design NC (noise criteria) sound level? Provide this information in Table 1. Are there any special acoustical considerations for any areas (areas close to the AHU, private areas, open office areas, etc.)? How will this criteria be met? (flexible duct, duct lining, fan type, lead wraps, diffuser type, TU damper type, etc.)

Noise class (NC) 35-40 for closed offices and 41-43 for open offices, recommended by ASHRAE)

Air Quality

For the general building and individual spaces, what is the desired outside air fraction or cfm per person and the number of persons per square foot? (Provide this information in Table 1). Is the outside air (OSA) controlled by CO₂ monitors? Explain. Are there airflow measurement devices provided?

Can occupants adjust ventilation? How and what limits apply to what areas?

Are there any special indoor pollutant source concentrations? How are they handled? List areas served by exhaust fans, the fan size, air changes per hour and operational control.

Is smoking of tobacco products allowed in or near the building? Y/N

How will the fresh air rate be maintained at low supply air volumes of the VAV system? Are perimeter zones treated differently than interior zones (reheat box damper settings, etc.)?

Where are the outside air intakes located? Are they near any potential sources of pollutants?

01 FEB 07

Are full-drain condensate pans used in the air handler units? ☐Yes / ☐No

What other special IAQ issues were considered?

Visual Quality

What are the design footcandle levels for the various spaces? (Provide this information in Table 1).
Why? Is additional task lighting assumed?

Do any spaces have special glare requirements? ☐Yes / ☐No

How will they be met? (special light fixtures and lenses, fixture layout, special CRT screens, etc.)

How will glare be controlled in daylit areas?

What are the parameters and sequences of operation for the daylighting controls and dimming lights? How will occupants interact with the system (overrides, education, etc.)?

Can occupants adjust the lighting system?

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

01 FEB 07

1.4 Landscaping

Design Intent

Describe the objectives and the elements of the specific landscape design that contribute to energy efficiency, water conservation, and comfort.

Sequences

What are the main control sequences for the watering systems that ensure water conservation?

Maintenance

Are there any special instructions as to the care of the landscape elements that will enhance or degrade their energy and comfort benefits? (refer to O&M manual sections, if applicable)

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

Number of sheets attached to this section: _____

Table 1

Reception, records, conference room, closed offices, open offices, exercise room, lunch room, inventory, stock, etc.

[illegible]

01 FEB 07

2 HVAC Systems and Design Parameters

2.1 General

General description of the main HVAC systems and areas served.

<u>System</u>	<u>Areas Served</u>

Why were the above particular systems chosen?

Describe the level of priority given to energy conservations for the system.

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

01 FEB 07

2.2 Specific System Descriptions

System	Heating / Cooling / Both	Areas Served

What is the rationale for the way the HVAC and lighting were zoned?

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

2.3 Load Calculations

What outdoor design conditions were assumed for load calculations?

Summer: DB_____ WB_____ Winter: DB_____

What indoor design conditions were assumed for load calculations?

Summer: DB_____ RH_____ Winter: DB_____ RH_____

Internal load assumptions: Lighting: _____ W/sf. Misc: _____ W/sf. Other: _____

SF/Person: _____ Btu/hr/person: sensible _____, latent _____

Ventilation: _____ cfm/person. Basis (code, etc.): _____

Infiltration: ☐ _____ cf/sf wall area, or ☐ _____ air changes per hour.

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01 FEB 07

Glazing:

Orientation	% of Wall Area	Overall U	SC
N			
S			
E			
W			

What overall safety factor was used and how much diversity was assumed for the heating, cooling plant and fan size?

For redundant equipment, what redundancy criteria were used?

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

Number of sheets attached to this section: _____

(Complete the following sections for each commissioned system as applicable or indicate “N/A”. Add sections with similar information for additional other anticipated commissioned systems as applicable)

01 FEB 07

3 Chiller System (Chillers, Cooling Towers, Pumps, Piping)

3.1 Design Intent (Provide this information for each chiller)

What is this chiller system used for? ☐ Supplies chilled water to air handler units to cool building space. ☐ Computer room AC units. ☐ Process chilled water

☐ Heat recovery for: _____

Other: _____

What areas of the building do this chiller serve? _____

List the areas that this chiller does not serve? _____

What types of air conditioning equipment serve the areas not served by this chiller? _____

What vibration and noise considerations are given to the location of this chiller? _____

What energy efficiency objectives are there for the chiller system? ☐ Highly efficient, ☐ Moderately efficient, ☐ Standard efficiency

What level of automatic control features are desired for this chiller system relative to automatic staging, optimization, central building automation system monitoring and control capabilities, etc.? ☐ Highly automated, ☐ Moderately automated, ☐ Minimally automated

What type of refrigerant will be used and why? _____

3.2 Basis of Design-Components Description and Methods for Meeting Design Intent

Chillers

Briefly describe the chiller system.

01 FEB 07

- | | |
|---|--|
| <input type="checkbox"/> Centrifugal <input type="checkbox"/> Screw
<input type="checkbox"/> Hermetically sealed
<input type="checkbox"/> Heat recovery
<input type="checkbox"/> Refrigerant type: _____
<input type="checkbox"/> Air cooled <input type="checkbox"/> Water cooled
<input type="checkbox"/> Evaporative cooled
<input type="checkbox"/> Capacity control type:
<input type="checkbox"/> Prerotation vanes
<input type="checkbox"/> Other: _____ | <input type="checkbox"/> Reciprocating chiller
<input type="checkbox"/> Heat recovery
<input type="checkbox"/> Refrigerant type: _____
<input type="checkbox"/> Air cooled <input type="checkbox"/> Water cooled
<input type="checkbox"/> Evaporative cooled
<input type="checkbox"/> Stages of unloading: _____
<input type="checkbox"/> Other: _____ |
|---|--|

How many chillers of each size are there? (size and number of each size): _____

Is there a standby / redundant chiller during design conditions? _____

Are there isolation valves for when only one chiller is running? _____

What method was used for determining the design cooling load? _____

Attach load calculations and assumptions, if not given in a previous section. (Diversity, safety factor, outdoor DB, WB, indoor DB, lighting W/sf, plug loads W/sf, sf/person, ventilation cfm/person, infiltration rate, glazing % of wall, overall U; SC).

Describe any provisions in the chiller system for accomodating future building or load expansion.

What evidence can be provided to show the chillers are not oversized? _____

Why were they chosen to be different or equal size? _____

Was variable compressor speed seriously considered? If not, why not? _____

Was heat recovery for the chiller analyzed? _____ Why or why not? _____

What were the results of the analysis? _____

What vibration and noise considerations were given to the model and features of the selected chillers? _____

What is the rated efficiency of each chiller at full load and the APLV, in kW/ton? _____

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01 FEB 07

What rationale was used to select these efficiencies with the sizes? Were more efficient models analyzed? _____

Attach engineering or energy simulation and economic calculations for the selections.

Are the chillers intended to be staged back and forth, depending on load, to minimize energy use?

Will staging occur manually or automatically? _____

What special control strategies will be employed with the chiller system? _____

What controls will be in place to allow the lowest economical entering condenser water temperature to be realized? What other options were considered besides this strategy? _____

Fully describe the interface that the building automation system has with the chiller system: _____

What control will the building automation system (BAS) have over the chiller system?

☐ BAS enables/disables the chiller, ☐ assigns the lead chiller, ☐ assigns the lead primary chilled water pump, ☐ assigns the lead secondary chilled water pump, ☐ assigns the lead condenser pump, ☐ assigns the lead cooling tower

The BAS monitors the following: ☐ LCHWT, ☐ RCHWT, ☐ ECDWT, ☐ LCDWT, ☐ CDW flow, ☐ CHW primary flow, ☐ Secondary CHW flow, ☐ Cooling tower bypass valve, ☐ Chiller alarms that report to BAS (list): _____

Other _____

The BAS can change the following: ☐ LCHWT setpoint, ☐ Reset parameters, ☐ ECDWT setpoint, ☐ Cooling tower fan staging parameters, ☐ Chilled water pumping pressure setpoints, ☐ Pressure reset parameters, ☐ Demand limits, ☐ Other _____

01 FEB 07

Cooling Tower

Describe the cooling tower (cross flow, counterflow, etc.) _____

What are the sizes of the cooling towers? _____

What is the approach temperature rating of the cooling tower? _____

Why was a lower approach not chosen? _____

Attach energy and economic analyses.

Were oversized cooling towers analyzed to improve chiller efficiency? _____ Why or why not?

Attach analysis.

How many motors are there per tower fan? _____ Describe. _____

Are the motors premium efficiency? _____

How is the fan speed controlled? _____

How do the sizes of the chillers affect the sizes of the cooling towers selected? Are they paired?

Can two cooling towers serve one chiller? _____

How are the cooling towers staged? _____

Will condenser water flows be monitored? _____ If not, explain why. _____

Will the cooling tower be used in winter? _____ Why? _____

Air or Evaporative Cooled Condenser

☐ Air cooled ☐ Evaporative cooled

Why was an air-cooled condenser chosen over a cooling tower? _____

01 FEB 07

Why was an air-cooled condenser chosen over an evaporative condenser? _____

Describe main features of the condensers and the chillers they serve. _____

Were more efficient models analyzed? (attach analysis) _____

Describe the staging features _____

Chilled and Condenser Water Pumps and Piping

What pressure drop range was the piping system designed to:

☐ Very low pressure drop, ☐ Moderately low pressure drop, ☐ Standard pressure drop. Was an analysis performed for using a lower pressure drop to reduce pump size and energy use? _____ Attach analysis. How were pipe losses determined? _____rule of thumb, _____detailed take-off and calculation, _____other.

Are piping circuits designed to be proportionally self-balancing, to minimize the restriction (head loss) of balancing valves and circuit setters?

Describe the pumps chosen. Primary: _____

Secondary: _____

Condenser pumps _____

Are they equipped with premium energy-efficient motors? _____

Why or why not? _____

How large of safety factor was considered in the pump sizing? _____

What was the over-sizing rationale for the pumps? ☐ Potential system expansion, ☐ Safety factor, ☐ Both of above. _____

ASHRAE 90.1 doesn't allow flow throttling with a balancing valve more than 3 hp. Will this system comply? If no, why not? _____

Would a more detailed head loss calculation likely result in a smaller safety factor and pump? _____

01 FEB 07

Describe any standby or redundant pumps and their operation. _____

Will the control sequences allow for automatic changeover to the lag or standby pump upon pump failure and similarly for cooling tower fan failure or will manual valving be required? Upon failure, does the lag pump or tower start or does the chiller go down and lag chiller start. Explain fully for each:

Primary chilled water pumps: _____

Secondary chilled water pumps: _____

Condenser water pumps: _____

Cooling tower fans: _____

How is the secondary chilled water capacity controlled? ☐ Variable speed drives (VFD) on pumps, ☐ Bypass valve. If by bypass valve, explain the rationale for not using variable speed drives and attach the economic analysis. _____

For VFD's, how will the pump speed be controlled? ☐ Constant water pressure setpoint, ☐ Reset water pressure setpoint. If the pressure is not reset, why not? _____

For a VFD on pressure reset, how low of speed will the pump be allowed to go? Is this as low as possible? Explain. _____

Will chilled water flows be monitored? ☐ Primary flow, ☐ Secondary flow. If not, explain. _____

01 FEB 07

Chiller System Sequence of Operations and Operating Parameters

Attach a full and comprehensive sequence of operations, including but not limited to the following conditions and systems, including all interactions:

Chiller, Cooling Tower and Pumps

- List parameter conditions that initiate start-up.
- Provide a detailed narrative of the full sequence and status and action of EACH component during EACH stage of start-up: low load, medium load, high load, staging to next chiller, up to full load on all chillers, and then back down again to OFF condition. List all setpoints, delays, parameters, conditions, etc., that are required to pass through each stage. The components for which status will be given at each stage are: chiller stage and load, primary, secondary and condenser pump status, speed and flow, cooling tower stage, cooling tower bypass valve, cooling tower fans and speed, pipe pressures and setpoint resets.

Describe the sequences for the following:

- Chiller optimization staging.
- Temperature lockouts.
- Status and sequence at power outage and fire alarm.
- Effects of manual shutoff or failure of chiller, primary pump and secondary pump, condenser pump, cooling tower fan, vibration alarm.
- List all alarms.
- Include full sequences and setpoints for capacity and pressure control of the secondary chilled water system.
- Include full sequences and setpoints for condenser water temperature control and cooling tower fan control parameters.
- Cooling tower sump heater sequences, parameters and setpoints.
- List the full sequence of operation for all energy conserving strategies, including their setpoints and parameters.
- Weekend operation.
- Normal occupied and unoccupied modes.

Equipment manufacturers' sequences and control drawings may be included, but will generally require additional narrative. Flow charts may be used if sufficiently detailed. Narrative and flow chart examples are found in Section 4 of the instructions.

For the chiller, cooling tower and pumps, the sequences are expected to be about five single-spaced, typewritten pages.

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

01 FEB 07

Number of sheets attached to this section: _____

01 FEB 07

4 Boilers and Heating Water System

4.1 Design Intent

Hot Water. What is this heating water system used for? ☐ Supplies hot water to air handler units to ___heat building space, ___preheat incoming cold air. ☐ Supplies hot water to ___perimeter VAV reheat terminal units, ___core VAV reheat terminal units.

Steam. What is the steam used for? ☐ Supplied to air handler units to ___heat building space, ___preheat incoming cold air. ☐ Supplies hot water to ___perimeter, ___core VAV reheat terminal units. ☐ Is converted to hot water in a converter before being used by the building. ☐ Is used for humidification of the building.

Other: _____

What areas of the building do the boilers serve? _____

List the areas that the boilers do not serve. _____

What types of heating equipment serve the areas not served by the boilers? _____

What vibration and noise considerations are given to the location of the boilers? _____

What energy efficiency objectives are there for the boiler system? ☐ Highly efficient, ☐ Moderately efficient, ☐ Standard efficiency

What level of automatic control features are desired for this boiler system relative to automatic staging, optimization, central building automation system monitoring and control capabilities, etc.? ☐ Highly automated, ☐ Moderately automated, ☐ Minimally automated

What type of fuel will be used and why? ☐ Natural gas, ☐ Fuel oil, ☐ Other _____

4.2 Basis of Design-Components Description and Methods for Meeting Design Intent

Boilers

The boiler is a ☐ Condensing, ☐ Forced draft, ☐ Atmospheric burner, ☐ Packaged, ☐ Other: _____

Briefly describe the boiler system.

01 FEB 07

How many boilers of each size and type are there? (list number and size): _____

Is there a standby / redundant boiler during design conditions? _____

What method was used for determining the design heating load? _____

Attach load calculations and assumptions, if not given in a previous section. (Diversity, safety factor, outdoor DB, WB, indoor DB, lighting W/sf, plug loads W/sf, sf/person, ventilation cfm/person, infiltration rate, glazing % of wall, overall U; SC).

Describe any provisions in the boiler system for accomodating future building or load expansion.

What evidence can be provided to show that the boilers are not oversized? _____

Why were they chosen to be different or equal size? _____

What vibration and noise considerations are given to the model and features of the chosen boilers? _____

How many total stages of capacity does each boiler have? (burner beds and stages of fire) _____

What is the rated efficiency of each boiler? _____

What rationale was used to select these efficiencies with the sizes? Were more efficient models analyzed? _____

Attach engineering or energy simulation and economic calculations for the selections.

Are the boilers intended to be staged back and forth, depending on load, to minimize energy use?

Will this be done manually or automatically? _____

What special control strategies will be employed with the boiler system? _____

01 FEB 07

 Fully describe the interface that the building automation system has with the boiler system: _____

What control will the building automation system (BAS) have over the boiler system?

☐ BAS enables/disables the boiler, ☐ assigns the lead boiler, ☐ assigns the lead primary boiler pump, ☐ assigns the lead secondary boiler water pump.

The BAS monitors the following: ☐ boiler alarm status, ☐ pump status, ☐ internal water temperature, ☐ steam pressure, ☐ HW primary flow, ☐ secondary HW flow, ☐ three-way mixing valve, ☐ boiler alarms that report to BAS (list): _____

Other _____

The BAS can change the following: ☐ LHWT setpoint, ☐ Reset parameters, ☐ Boiler water pumping pressure setpoints, ☐ Pressure reset parameters, ☐ Demand limits, ☐ Other _____

Will the boilers have low water cutout controls? _____

4.3 Heating Water Pumps and Piping

What pressure drop range was the piping system designed to?

☐ Very low pressure drop, ☐ Moderately low pressure drop, ☐ Standard pressure drop. Was an analysis performed for using a lower pressure drop to reduce pump size and energy use? _____ Attach analysis. How were pipe losses determined? _____rule of thumb, _____detailed take-off and calculation, _____other.

Are pipe circuits designed to be close to being self-balanced proportionally, to minimize the restriction (head loss) of balancing valves and circuit setters?

Describe the pumps chosen. Primary: _____

Secondary: _____

Are they equipped with premium energy-efficient motors? _____

Why or why not? _____

01 FEB 07

How large of safety factor was used in the pump sizing? _____ What was the over-sizing rationale for the pumps? ☐ Potential system expansion, ☐ Safety factor, ☐ Both of above. _____

ASHRAE 90.1 doesn't allow flow throttling with a balancing valve more than 3 hp. Will this system comply? If no, why not? _____

Would a more detailed head loss calculation likely result in a smaller safety factor and pump? _____

Describe any standby or redundant pumps and their operation. _____

Will the control sequences allow for automatic changeover to the lag or standby pump upon pump failure or will manual valving be required? Explain fully. _____

Primary heating water pumps: _____

Secondary heating water pumps: _____

How is the secondary heating water capacity controlled? ☐ Variable speed drives (VFD) on pumps, ☐ Bypass valve(s). If bypass valves, explain the rationale for not using variable speed drives and attach the economic analysis. _____

For VFD's, how will the pump speed be controlled? ☐ Constant water pressure setpoint, ☐ Reset water pressure setpoint. If the pressure is not reset, why not? _____

For a VFD on pressure reset, how low of speed will the pump be allowed to go? Is this as low as possible? Explain. _____

Will heating water flows be monitored? ☐ Primary flow, ☐ Secondary flow. If not, explain. _____

How is supply water temperature controlled? ☐ 3-way mixing valve, ☐ Other _____

4.4 Boiler System Sequence of Operations and Operating Parameters

Attach a full and comprehensive sequence of operations, including but not limited to the following conditions and systems, including all interactions:

- List parameter conditions that initiate start-up.

USACE LEED Basis of Design Template
(Based on PECl Model Commissioning Plan and Guide Specifications document PECl
D_INTENT.V08)

01 FEB 07

- Provide a detailed narrative of the full sequence and status and action of EACH component during EACH stage of start-up: low load, medium load, high load, staging to next boiler, up to full load on all boilers, and then back down again to OFF condition. List all setpoints, delays, parameters, lockouts, conditions, etc., that are required to pass through each stage. The components for which status will be given at each stage are: boiler stage and load, primary, secondary pump status, speed and flow, pipe pressures and setpoint resets.

Describe the sequences for the following:

- Boiler optimization staging.
- Temperature lockouts.
- Status and sequence at power outage and fire alarm.
- Effects of manual shutoff or failure of boiler, primary pump and secondary pump.
- List all alarms.
- Include full sequences and setpoints for capacity and pressure control of the secondary heating water system.
- List the full sequence of operation for all energy conserving strategies, including their setpoints and parameters.
- Weekend operation.
- Normal occupied and unoccupied modes.
- Warm-up mode

Equipment manufacturers' sequences and control drawings may be included, but will generally require additional narrative. Flow charts may be used if sufficiently detailed. Narrative and flow chart examples are found in Section 4 of the instructions.

For the boiler and pumps, the sequences are expected to be about ____ single spaced, typewritten pages.

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

Number of sheets attached to this section: _____

01 FEB 07

5 Roof Top Packaged System(s) (RTU)

5.1 Design Intent

What is this system or component used for? _____

Systems Description

Briefly describe the system:

- | | |
|--|--|
| <input type="checkbox"/> Heat pump | <input type="checkbox"/> Steam |
| <input type="checkbox"/> Gas pack | <input type="checkbox"/> Constant volume |
| <input type="checkbox"/> AC only | <input type="checkbox"/> Dual duct |
| <input type="checkbox"/> Resistance coil | <input type="checkbox"/> Multizone |
| <input type="checkbox"/> Hot water | <input type="checkbox"/> Other _____ |
| <input type="checkbox"/> VAV | <input type="checkbox"/> Other _____ |

List equipment and areas served: _____

5.2 Basis of Design-Components Description and Methods for Meeting the Design Intent

Give size, quantity, and other specific information and the areas served, and how it will meet the objectives.

Plant

Number of units of this type: _____ EER (cooling): _____ Tons cooling each unit: _____

Accumulated capacity for all units of this type: Total tons cooling: _____

MBtu heating: _____ Heat Pump COP: _____ Gas efficiency: _____

Areas served: _____

Supply Fans and Capacity Control

Total CFM for packaged systems of this type: _____

☐ Inlet vanes ☐ VFD ☐ Vane axial ☐ Outlet damper ☐ Other: _____

Motor efficiency: _____ Std. effic., _____ Premium effic.

Return Fans / Exhaust Fans / Relief Dampers

Describe return fans, exhaust fans, or relief dampers, if any, and their function.

01 FEB 07

Describe how building static pressure is controlled (setpoints, etc.). _____

VFD control:

Which fans does each VFD control? ☐ Supply ☐ Return/Exhaust

Location of duct static-pressure sensor (distance from fan and proximity from branch takeoffs up and down stream): _____

Duct static pressure: ☐ Fixed setpoint / ☐ Reset or variable

Expected duct static pressure setpoint (or average if reset): _____

Total pressure across fan at design flow: _____ [discharge pressure - suction pressure (negative)]

Minimum fan capacity (lower frequency limit setting in VFD, % of max.) _____

Are VFD settings ☐ monitored or ☐ controlled by the BAS system? (check one)

Method used for sizing ducts _____ equal friction _____ static regain

Note: Equal friction gives smaller ducts and higher pressure requirements. If equal friction was used, was a calculation made to make sure the increased pressure and subsequent increase in energy use by the fan is more than offset by the savings in duct materials? _____ If no, why not? _____

Compressor(s)

Number of compressors per RTU: _____. Low ambient compressor package? _____

Number of condenser fans per RTU: _____. Locked out during morning warmup? _____

Compressor capacity control; general description:

Cooling coil

Provide general description and any special features (high efficiency, face velocity, low pressure drop, etc.). Was a low pressure drop coil analyzed? What were the results?

Dampers

Describe the dampers and their function. _____

01 FEB 07

Smoke and Fire DampersDescribe the smoke and fire damper system (location and operation). _____

_____**Setpoint Temperatures**

Supply air (SA): _____ SA reset (see strategy sequence): _____ Mixed air: _____

FiltersProvide general description and any special features (low pressure drop, etc.). Were low pressure drop filters analyzed? What were the results? _____

_____**Heating System**Describe type, fuel, perimeter reheat, areas served, etc.

_____**Economizer and OSA Dampers**☐ Enthalpy ☐ Dry Bulb ☐ Integrated ☐ Economizer is first stage of coolingNumber of damper positions: ☐ _____ or ☐ infinite.Dampers closed during warm-up? ☐ Yes / ☐ No

If dry-bulb type: OSA changeover temperature: _____

If enthalpy: OSA enthalpy changeover: _____

Other special features of the RTU:

_____How will the fresh air rate be maintained at low supply air volumes of the VAV system? Are perimeter zones treated differently than interior zones (reheat box damper settings, etc.)?

_____How is the RTU controlled?

USACE LEED Basis of Design Template
(Based on PECl Model Commissioning Plan and Guide Specifications document PECl
D_INTENT.V08)

01 FEB 07

- ☐ Stand-alone controllers with thermostats in zones
- ☐ Above, but enabled/disabled by central building automation system (BAS)
- ☐ Integrated into BAS as below:

Integration of Control and Monitoring Points With the BAS

Point or Feature	BAS Monitors	BAS Can Change SetPts	Point or Feature	BAS Monitors	BAS Can Change SetPts
Mixed air temp.	_____	_____	Compressor stage		NA
RA temp.	_____	NA	Bldg. static pressure	_____	_____
SA temp	_____	_____	Temp. lockouts	_____	_____
SA reset parameters	_____	_____	CO ₂ for OSA control	_____	_____
RA enthalpy	_____	NA	Htg. coil position	_____	NA
DA static pressure	_____	_____	Optimum start	NA	_____
Duct static pressure	_____	_____	Night purge	NA	_____
Supply fan statuc	_____	NA	Demand limit	NA	_____
Ret./Exh. fan status	_____	NA	Alarms (list):	_____	_____
Supply fan speed	_____	NA	-Dirty filter	_____	_____
Ret./Exh. fan speed	_____	NA	-Compressor fail	_____	_____
Supply fan cfm	_____	NA	-Fan loss of air	_____	_____
Ret./Exh. fan cfm	_____	NA	-High DA pressure	_____	_____
Inlet vane position	_____	NA	-Fire/smoke	_____	_____
Filter Diff. pressure	_____	_____	-Emerg. shutdown	_____	NA
Occup. schedule override	_____	_____	OSA compensation for VAV	_____	_____
Night low limits	_____	_____	OSA economizer	_____	_____
_____	_____	_____	_____	_____	_____

Describe other equipment tied to the ON/OFF status of the RTU (exhaust fans, etc.)

01 FEB 07

5.3 RTU Sequence of Operations and Operating Parameters

Provide a full and comprehensive sequence of operations, including but not limited to the following conditions and systems, including all interactions:

Systems	Conditions or Modes
<ul style="list-style-type: none">• supply fans• exhaust fans• return air and exhaust dampers• supply air capacity control• economizer and OSA dampers• building static pressure control• coil valve operation• CO₂ sensor OSA control• smoke dampers	<ul style="list-style-type: none">• start-up• shut-down• normal occupied & unoccupied periods• warm-up• temperature lockouts• compressor and condenser staging• override sequences• winter/summer changeover• weekend operation• normal operation heating• normal operation cooling• through deadband ranges• alarms: fire, smoke, shutdown, equip. failure, temp. and pressure limits, etc.• all energy conserving strategies (optimum start/stop, resets, etc.)• fire alarm

Include the position or status at which each component resides at start-up,what occurs at fire alarm, provide all setpoints and control parameters, including all time delays. In the sequences, describe what controls what. That is, what components must be ON or at certain conditions in order for others to operate. Equipment manufacturers’ sequences and control drawings may be included, but will generally require additional narrative. Flow charts may be used if sufficiently detailed. Narrative and flow chart examples are found in Section 4 of the instructions.

For this RTU system, these sequences are expected to be about _____ single spaced, typewritten pages.

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

Number of sheets attached to this section: _____

01 FEB 07

6 VAV Terminal Units—Air Conditioning Only (TU_AC)

6.1 System Description

Briefly describe the TU: _____

Number of TU_ACs: _____ Type of area served: _____

TU type: ☐ pressure independent / ☐ pressure dependent

Minimum air damper position: _____% open.

Are these fan powered? _____. ☐ Parallel, ☐ Series. Why? _____

TU measures air flow via total and static pressure sensors. Y/N ____.

☐ Cross, ☐ Linear flow station? Other flow method: _____

Describe TU controller type: _____

Damper actuator type: ☐ Electric, ☐ Pneumatic.

What noise considerations were used when specifying the TU's? _____

Integration of Control and Monitoring Points With the BAS

Point or Feature	BAS Monitors	BAS Can Change SetPts	Point or Feature	BAS Monitors	BAS Can Change SetPts
TU air flow	_____	_____	TU air flow max.	_____	_____
TU air flow min.	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

6.2 TU_AC Sequence of Operations and Operating Parameters

Provide a full and comprehensive sequence of operations (including all sequences, deadband, alarm actions, etc.) on a separate sheet(s) and attach to this section of the form.

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

01 FEB 07

Number of sheets attached to this section: _____

01 FEB 07

7 VAV Terminal Units—Reheat (TU_RH)

7.1 System Description

Briefly describe the TU: _____

Number of TU_RHs: _____ Type of area served: _____

TU type: ☐ pressure independent / ☐ pressure dependent, ☐ VAV, ☐ constant volume

Are these fan powered? _____. ☐ Parallel, ☐ Series. Number of fan speeds? _____

Why? _____

What provisions will be made to minimize reheat? _____

What provisions will be made to minimize system simultaneous heating and cooling? _____

TU measures air flow via total and static pressure sensors. Y/N ____.

☐ Cross, ☐ Linear flow station? Other flow method: _____

Minimum air damper position: _____% open.

When the damper is at minimum in heating and space setpoint is not being maintained, will dampers open? _____ Why? _____

Describe TU controller type: _____

Damper actuator type: ☐ Electric, ☐ Pneumatic.

Heating coil type: ☐ hot water, ☐ electric resistance and stages ____.

Describe heating coil valve: ☐ Two position, ☐ Modulating. _____

Heating valve actuator type: ☐ Electric, ☐ Pneumatic.

Do some units have 3-way valves? Why? _____

Automatic flow control valve? ____ Describe: _____

What noise considerations were used when specifying the TU's? _____

01 FEB 07

Integration of Control and Monitoring Points With the BAS

Point or Feature	BAS Monitors	BAS Can Change SetPts	Point or Feature	BAS Monitors	BAS Can Change SetPts
TU air flow	_____	_____	TU air flow max.	_____	_____
TU air flow min.	_____	_____	Valve position	_____	_____
_____	_____	_____	_____	_____	_____

7.2 TU_RH Sequence of Operations and Operating Parameters

Provide a full and comprehensive sequence of operations (including heat lockout parameters, heating valve sequences, deadbands, alarm actions, etc.) on a separate sheet(s) and attach to this section of the form.

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

Number of sheets attached to this section: _____

01 FEB 07

8 Heat Recovery Unit (HRU)

8.1 Design Intent

Describe the purpose of the HRU: _____

8.2 System Description

Briefly describe the system: _____

On which air handlers does this system operate? _____

Integration of Control and Monitoring Points With the BAS

Point or Feature	BAS Monitors	BAS Can Change SetPts	Point or Feature	BAS Monitors	BAS Can Change SetPts
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

8.3 HRU Sequence of Operations and Operating Parameters

Provide a full and comprehensive sequence of operations (including seasonal variations) on a separate sheet(s) and attach to this section of the form.

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

Number of sheets attached to this section: _____

01 FEB 07

9 Computer Room Air Conditioning Unit (CRACU)

9.1 Design Intent

What is this system or component used for?

General Description

Briefly describe the system or component.

9.2 Basis of Design-Component Description and Methods for Meeting the Design Intent

Areas served: _____

Number of CRACUs: _____ Sizes (tons) _____ EER: _____

Location of CRACU: _____

☐ Ducted system or ☐ discharge only? _____

How is heat rejected? ☐ Cooling tower / ☐ DX air-cooled condenser / ☐ Other

Location of condenser: _____

Humidifier description: _____

Reheat description: _____

Is there a 3-way valve in the unit? _____ Will this defeat the purpose of any variable speed drives on the chilled water system? _____

How is the CRACU controlled?

- ☐ Stand-alone controllers with thermostats in zones
- ☐ Same, but enabled/disabled by central building automation system
- ☐ "fully" controlled by BAS

Does supply air enter this space from the main HVAC system? ☐ Yes / ☐ No

If Yes, when? _____

How is fresh air brought into and controlled in the space? _____

01 FEB 07

Integration of Control and Monitoring Points With the BAS

Point or Feature	BAS Monitors	BAS Can Change SetPts	Point or Feature	BAS Monitors	BAS Can Change SetPts

9.3 CRACU Sequence of Operations and Operating Parameters

Provide a full and comprehensive sequence of operations (including setpoints, unoccupied, occupied, fire alarm periods, etc.) on a separate sheet(s) and attach to this section of the form.

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

Number of sheets attached to this section:

01 FEB 07

10 Daylighting Controls

10.1 Design Intent

Briefly describe the system: _____

What is the primary reason for using daylighting? ☐ energy savings / ☐ view/aesthetics
☐ visual light quality

What budget limitations were there? _____

10.2 Basis of Design

System type: ☐ continuous dimming / ☐ stepped dimming in ____ steps

Describe related architectural features such as light shelves, sloped ceilings, skylights, special interior finishes, intended furniture systems, etc. _____

How low are the lights allowed to dim? _____%.

The system is controlled by: ☐ main BAS / ☐ stand alone controllers

What is the light level setpoint(s) at the work plane:

<u>Area</u>	<u>Design Foot Candles</u>
_____	_____
_____	_____
_____	_____
_____	_____

How deep into the building do the lights dim? _____ft.

Are the dimming rates the same across this distance? ☐ Yes / ☐ No

Explain: _____

What areas of the building have dimming control?

01 FEB 07

How many zones and controllers (light sensors) are there? _____

How do occupants override the dimming? _____

Who has access for adjusting light levels? _____

Where are these adjustments made? _____

Where are the sensors located? _____

10.3 Sequence of Operations and Operating Parameters

Provide a full and comprehensive sequence of operations (including setpoints and occupied and unoccupied conditions, etc.) on a separate sheet(s) and attach to this section of the form.

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

Number of sheets attached to this section: _____

01 FEB 07

11 Lighting Sweep Control

11.1 System Description

Briefly describe the system: _____

11.2 Operating Parameters

The system is controlled by: ☐ Main BAS / ☐ Stand-alone controller

How many zones will there be? _____ Describe the zones. _____

What is the floor area of the largest zone? _____

How many sweeps will there be? _____

At what times?

Weekdays: _____

Saturday: _____

Sunday: _____

Describe the type of switching system that occupants will use to turn the lights back on in their zone. _____

What is the maximum override duration? _____ hours

Who will be able to globally override the sweeps or change the schedule?

How will the sweeps work with housekeeping schedules? _____

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

Number of sheets attached to this section: _____

01 FEB 07

12 Building Automation System (BAS)

12.1 Design Intent

Briefly describe the system: _____

Why was this system chosen over others considered? _____

Describe any budget limitations: _____

How important was energy conservation in the decision of BAS type? _____

12.2 Basis of Design—Component Description and Methods for Meeting the Design Intent

Central system is: ☐ DDC, ☐ pneumatic

Valve actuators: ☐ electric, ☐ pneumatic

AHU damper actuators: ☐ electric, ☐ pneumatic

VAV terminal box damper actuators: ☐ electric, ☐ pneumatic

Fire / smoke damper actuators: ☐ electric, ☐ pneumatic

User interface: ☐ graphical display of components

Limitations of the modules or features specified, compared to the highest model line system:

Check the systems that the BAS will control (vs local equipment, packaged controllers). Refer to the individual system section for a complete description of the points and their control by the BAS

01 FEB 07

	Virtually Full Control	Partial Control	Enable/Disable Only	Monitor Only
Rooftop packaged unit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air handler unit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Terminal units	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Economizer functions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Boiler plant	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Heating water pumping system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chiller plant	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chilled water pumping system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cooling tower	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Condenser water pumping	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Terminal unit settings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Heat recovery unit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Daylighting setpoints	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lighting sweep control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Exterior lighting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Computer room HVAC unit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fan coil unit and condenser	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Unit heaters	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Smoke and fire control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Emergency power system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
UPS power system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Service water heating pump	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Location of user interface: _____

Type of user interface:

- ☐ Permanent on-site computer terminal
☐ Plug-in portable computer
☐ Remote terminal of _____
☐ Keypad only

Describe parties who will be able to change schedules only: _____

Describe parties who will have full access to system: _____

01 FEB 07

Check the energy conserving control strategies that will be operational in this building through the BAS.

- | | |
|--|---|
| <input type="checkbox"/> Holiday scheduling | <input type="checkbox"/> Occupancy-based outside air control |
| <input type="checkbox"/> Zonal scheduling | <input type="checkbox"/> DX compressor optimization |
| <input type="checkbox"/> Sequential startup of equipment | <input type="checkbox"/> Mixed air temperature control |
| <input type="checkbox"/> Lighting sweep | <input type="checkbox"/> Boiler staging and optimization |
| <input type="checkbox"/> Night setup/setback | <input type="checkbox"/> Heat element (coil) staging |
| <input type="checkbox"/> Optimum start | <input type="checkbox"/> Hot water reset |
| <input type="checkbox"/> Optimum stop | <input type="checkbox"/> Heat recovery option control |
| <input type="checkbox"/> Hot & cold deck reset (supply air) | <input type="checkbox"/> Water-side economizer control |
| <input type="checkbox"/> Chilled water reset | <input type="checkbox"/> Variable speed pump control |
| <input type="checkbox"/> Chiller staging and optimization | <input type="checkbox"/> Occupancy based HVAC control |
| <input type="checkbox"/> Cooling tower component staging | <input type="checkbox"/> Terminal regulated air volume (TRAV) |
| <input type="checkbox"/> Air-side economizer control | <input type="checkbox"/> Thermal storage control |
| <input type="checkbox"/> Night ventilation purge / pre-cooling | <input type="checkbox"/> Demand limiting or load shedding |
| <input type="checkbox"/> CO2 outside air rate control | <input type="checkbox"/> Duty cycling of equipment |
| <input type="checkbox"/> VAV control-pressure independent | <input type="checkbox"/> DHW recirculation pump control |
| <input type="checkbox"/> VAV control-pressure dependent | <input type="checkbox"/> DHW temperature control |
| <input type="checkbox"/> Duct static pressure reset | <input type="checkbox"/> Full trending capabilities |
| <input type="checkbox"/> _____ | <input type="checkbox"/> _____ |
| <input type="checkbox"/> _____ | <input type="checkbox"/> _____ |
| <input type="checkbox"/> _____ | <input type="checkbox"/> _____ |

List all special monitoring points installed for diagnostic, performance verification and trouble shooting purposes. Which are not needed to execute the control sequences and strategies?

12.3 BAS Sequence of Operations and Operating Parameters

Provide a full and comprehensive sequence of operations, including setpoints, deadbands, etc. List full control sequences for all control strategies. Refer to sequences already provided in other component sections, if applicable. List on a separate sheet(s) and attach to this section of the form.

Include the position or status at which each component resides at start-up, provide all setpoints and control parameters, including all time delays. In the sequences, describe what controls what. That is, what components must be ON or at certain conditions in order for others to

01 FEB 07

operate. Equipment manufacturers' sequences and control drawings may be included, but will generally require additional narrative. Flow charts may be used if sufficiently detailed. Narrative and flow chart examples are found in Section 4 of the instructions.

Note: Complete BAS description, points list with all details, program listing, etc. are not part of the design intent, but will be required as part of the O&M documentation.

12.4 Points List

For this design intent, list all points in a table that includes at **least** the information shown in the following example table.

Controlled System	Point Abbr.	Point Description	Display Units	Control or Setpoint Y/N	Monitoring Point Y/N	Intermediate Point Y/N	Calculated Point Y/N

Key:

Point Description: DB temp, airflow, etc.

Control or Setpoint: Point that controls equipment and can have its setpoint changed (OSA, SAT, etc.)

Intermediate Point: Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control reset).

Monitoring Point: Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.

Calculated Point: "Virtual" point generated from calculations of other point values.

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

Number of sheets attached to this section: _____

01 FEB 07

13 Split ___ Air Conditioning; ___ Heat Pump System**13.1 Design Intent**

What is this system or component used for? _____

_____**Systems Description**

Briefly describe the system:

- | | |
|---|--|
| <input type="checkbox"/> DX AC only | <input type="checkbox"/> VAV |
| <input type="checkbox"/> Heat Pump and AC | <input type="checkbox"/> Constant volume |
| <input type="checkbox"/> Resistance coil | <input type="checkbox"/> Dual duct |
| <input type="checkbox"/> Hot water coil | <input type="checkbox"/> Multizone |
| <input type="checkbox"/> Gas furnace | <input type="checkbox"/> Other _____ |
| | <input type="checkbox"/> Other _____ |

List equipment and areas served: _____

_____**13.2 Basis of Design-Component Description and Methods for Meeting the Design Intent**

Give size, quantity, and other specific information and the areas served, and how it will meet the objectives.

Plant

Number of units of this type: _____ EER (cooling): _____ Tons cooling each: _____

Accumulated capacity for all units of this type: Total tons cooling: _____

MBtu heating: _____ Heat Pump COP: _____ Gas efficiency: _____

Areas served: _____

Compressor(s) and Condenser(s)

Number of compressors per condenser unit: _____. Low ambient compressor package? ____

Number of condenser fans condenser unit: _____

Compressor capacity control; general description: _____

USACE LEED Basis of Design Template
(Based on PEI Model Commissioning Plan and Guide Specifications document PEI
D_INTENT.V08)

01 FEB 07

Evaporator / Cooling Coil

Provide general description and any special features (high efficiency, face velocity, low pressure drop, etc.). Was a low pressure drop coil analyzed? What were the results?

Supply Fans and Capacity Control

Total CFM for inside fan coil or air handler of this type: _____

- ☐ Constant volume ☐ Inlet vanes ☐ VFD ☐ Vane axial ☐ Outlet damper ☐ Other: ____
- ☐ Evaporator fan cycles ON and OFF with compressor. Motor efficiency: ____Std. effic.,
____Premium effic.

Dampers

Describe any dampers and their function. _____

Smoke and Fire Dampers

Describe the smoke and fire damper system (location and operation). _____

Setpoint Temperatures

Supply air (SA): _____ SA reset (see strategy sequence): _____

Filters

Provide general description and any special features (low pressure drop, etc.). Were low pressure drop filters analyzed? What were the results? _____

Heating System

Describe type, fuel, perimeter reheat, areas served, etc.

01 FEB 07

Economizer and OSA Dampers

☐ No OSA via this unit ☐ Enthalpy ☐ Dry Bulb ☐ Integrated ☐ Economizer is first stage of cooling

Number of damper positions: ☐ _____ or ☐ infinite.

Dampers closed during warm-up? ☐ Yes / ☐ No

If dry-bulb type: OSA changeover temperature: _____

Other special features of the split system:

How will the fresh air rate be maintained at low supply air volumes of the VAV system? Are perimeter zones treated differently than interior zones (reheat box damper settings, etc.)?

How is the split system controlled? _____

☐ Stand-alone controllers with thermostats in zones. Number of zones: _____

☐ Above, but enabled/disabled by central building automation system (BAS)

☐ Integrated into BAS as below:

Integration of Control and Monitoring Points With the BAS

Point or Feature	BAS Monitors	BAS Can Change SetPts	Point or Feature	BAS Monitors	BAS Can Change SetPts
RA temp.	_____	NA	Compressor stage	_____	NA
SA temp	_____	_____	Temp. lockouts	_____	_____
SA reset parameters	_____	_____	CO ₂ for OSA control	_____	_____
RA enthalpy	_____	NA	Htg. valve position	_____	NA
DA static pressure	_____	_____	Optimum start	NA	_____
Duct static pressure	_____	_____	Night purge	NA	_____
Supply fan status	_____	NA		NA	_____
Ret./Exh. fan status	_____	NA	Alarms (list):	_____	_____
Occup. schedule override	_____	_____	Night low limits	_____	_____
OSA economizer	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

USACE LEED Basis of Design Template
(Based on PECl Model Commissioning Plan and Guide Specifications document PECl
D_INTENT.V08)

01 FEB 07

Describe other equipment tied to the ON/OFF status of the split system unit (exhaust fans, etc.)

13.3 Split System Sequence of Operations and Operating Parameters

Provide a full and comprehensive sequence of operations, including but not limited to the following conditions and systems, including all interactions:

Systems	Conditions or Modes
<ul style="list-style-type: none">• supply fans• supply air capacity control• economizer and OSA dampers• building static pressure control• coil valve operation• CO₂ sensor OSA control• smoke dampers	<ul style="list-style-type: none">• start-up• shut-down• normal occupied & unoccupied periods• warm-up• temperature lockouts• compressor and condenser staging• override sequences• winter/summer changeover• weekend operation• normal operation heating• normal operation cooling• through deadband ranges• alarms: fire, smoke, shutdown, equip. failure, temp. and pressure limits, etc.• all energy conserving strategies (optimum start/stop, resets, etc.)• fire alarm

Include the position or status at which each component resides at start-up, what occurs at fire alarm, provide all setpoints and control parameters, including all time delays. In the sequences, describe what controls what. That is, what components must be ON or at certain conditions in order for others to operate. Equipment manufacturers' sequences and control drawings may be included, but will generally require additional narrative. Flow charts may be used if sufficiently detailed. Narrative and flow chart examples are found in Sections 4 of the instructions.

For this system, these sequences are expected to be about _____ single spaced, typewritten pages.

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

01 FEB 07

Number of sheets attached to this section: _____

01 FEB 07

14 Emergency Power System

14.1 Design Intent

Briefly describe the system: _____

What is the purpose of the emergency power and any UPS for each load other than the fire, life, safety loads?

14.2 Basis of Design-Component Description and Methods for Meeting the Design Intent

Generator

Is the generator sized to be able to handle additional loads? _____ How many? _____

What is the maximum time it should take the generator to be providing power from the time street power is lost (seconds)? _____

Is there an automatic generator exercizer? _____

For how long should the generator be able to provide power without refueling? _____

Describe any special frequency and voltage regulation output requirements for the generator. _

Power Quality

Describe any special power quality concerns or considerations (sensitive equipment, etc.). _____

UPS

How many UPS systems are there? List all, including integral batteries in equipment. _____

What kind of UPS bypass will be used on the stand-alone UPS? _____

01 FEB 07

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

Number of sheets attached to this section: _____

01 FEB 07

15 Service Water Heating

15.1 Design Intent

Service Water. What does the system serve? _____

What energy efficient objectives are there for the service water system? _____

What is the fuel type and why? ___ Natural gas, ___ Electricity, ___ # ___ Fuel oil, ___ Steam,
___ deg F water.

15.2 System Description

Service Water. Briefly describe the system. _____

15.3 Basis of Design

What is the type of water heater and why? ___ Storage tank type, ___ Instantaneous type

What is the burner type? ___ Natural draft, ___ Forced draft

Is there a return water circulation pump and why and how is it controlled? _____

If it is a non-recirculating system is there a heat trap? _____

What is the water storage temperature? ___ deg F

What is the water supply temperature? ___ deg F

Is there a mixing valve and what type? _____

What is rated efficiency of the water heater? _____

What is the method used for determining the domestic water pipe size, storage tank size and heating load? _____

Attach calculations and assumptions.

Applicable References

What are the applicable codes, guidelines, standards, regulations, criteria and other references that will be followed relating to this section?

01 FEB 07

Number of sheets attached to this section: _____

01 FEB 07

16 OTHER SYSTEMS NEEDING SAMPLE FORMATS

Fire Alarm and Protection Systems	
Air Handler Units	Capacity control
	Supply fan
	Return/exhaust fan and dampers
	Heating and cooling coil valves
	Economizer and OSA and return air dampers
	Mixed air control
Exhaust Fans	